THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY—VOL. II.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.

REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH
DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY, LL.D., Ph.D., &c.

ONE OF THE NATURALISTS OF THE EXPEDITION

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CONTENTS.

EDITORIAL NOTES.

This volume contains Parts IV., V., VI., and VII. of the Physical and Chemical series of Reports on the Scientific Results of the Expedition.

Part IV.—While conducting the experimental work connected with the behaviour of the Challenger thermometers under pressure, a Report on which forms Appendix A to Volume II. of the Narrative of the Cruise, a number of subsidiary experiments of great interest, more or less connected with Ocean Physics, were suggested and partly carried out by Professor Tait. These and cognate matters were more fully investigated subsequently, and formed the basis of the present Report by Professor Tait "On some of the Physical Properties of Fresh and Sea Water." This title by no means indicates the variety of the subjects treated of experimentally and otherwise; for instance, the compression of glass, salt solutions, and mercury are investigated, and a discussion is given of the curious question (raised by Laplace's researches) of the internal pressure of a liquid mass, and historical details on these subjects are recorded. An examination of the Report will show the great amount of experimental and other work that was necessary for the production of this most valuable paper.

The Report occupies 76 pages of letterpress, illustrated by 2 plates.

Part V.—Previous to the departure of the Challenger Expedition in 1872, discussions of the more fundamental problems of meteorology relative to the diurnal changes in atmospheric pressure, temperature, humidity, and wind, were almost exclusively restricted to observations made on land. It had then, however, become evident that data supplied exclusively by observations on land, which occupies little more than a fourth part of the earth's surface, were altogether inadequate to a right con-

ception and explanation of meteorological phenomena; and accordingly when the Challenger Expedition was fitted out, arrangements were made for taking, during the cruise, hourly or two-hourly observations. These observations, which are published *in extenso* in the Narrative of the Cruise, Vol. II. pp. 305–744, are by far the most complete yet made of the meteorology of the ocean.

As is well known, elaborate observations were also made on deep-sea temperatures, which gave results of the first importance in terrestrial physics, and opened for discussion the broad question of oceanic circulation, on a sound basis of well-ascertained facts; but a right understanding of this subject demands, in the first place, a full discussion of atmospheric phenomena. Now any such discussion requires, for its proper handling, maps showing for the months of the year the mean pressure, mean temperature, and prevailing winds of the globe, with extensive tables from which these data have been obtained. The only works available were Dove's Isothermals, 1852; Buchan's Isobars and Prevailing Winds, 1869; and Coffin's Winds of the Globe, 1875;[1] all of which were based, necessarily when written, on defective data. This remark applies more particularly to the vitally important element of the prevailing winds, which were based on observations in very many cases too short continued to give good averages.

A re-discussion of all the available information regarding the different atmospheric phenomena, with special reference to the Challenger observations, was therefore most desirable; this work was undertaken in 1882, at my request, by Mr. Alexander Buchan, and since that date, upwards of seven years, it has occupied most of his time with that of his assistants. The data thus collected and prepared are given in the nine Tables of the Appendices to this Report, of which the more important are the mean diurnal variation of atmospheric pressure at 147 Stations, the mean monthly and annual pressure of the atmosphere at 1366 Stations, and a similar table of temperature at 1620 Stations, and the mean monthly and annual direction of the wind at 746 Stations. These Tables may be

[1] Dove, On the Distribution of Temperature over the Globe, 1852, and for N. Hemisphere, 1864; Buchan, On the Mean Pressure of the Atmosphere and Prevailing Winds over the Globe, *Trans. Roy. Soc. Edin.*, vol. xxv. p. 575, 1869; Coffin and Woeikof, On the Winds of the Globe, Smithsonian Contributions to Knowledge, 1875.

regarded as including all information at present existing which is necessary for the discussion of the broad questions raised in this Report.

The Report itself is divided into two parts, the first dealing with diurnal, and the second with monthly, annual, and recurring phenomena. The former part is the first attempt yet made to deal with the diurnal phenomena of meteorology over the ocean, — the pressure, temperature, humidity, and movements of the atmosphere, together with such phenomena as squalls, precipitation, thunder-storms and lightning. The results are equally novel and important, and when combined with analogous results obtained from land observations, enable us to take an intelligent and comprehensive grasp of these phenomena in their relations to the terraqueous globe taken as one whole. In several cases, notably the diurnal phenomena of atmospheric pressure, the results of observation will necessitate the revision of all theories of the diurnal fluctuations of pressure that have assumed a diurnal change of the temperature of the surface on which the atmosphere rests as a necessary cause of these fluctuations.

The second part of the Report attempts to give a comparative view of the climatologies of the globe to a degree of completeness not previously attempted. No effort has been spared to secure that the three outstanding elements of climate, pressure, temperature and winds, be represented by means for the same period of time, viz. the fifteen years ending with 1884. This end has been virtually secured for nearly all the land surfaces of the globe inhabited by civilized man, and this more particularly holds good in extra-tropical regions, where averages for the same period of time become more indispensable in discussing comparative climatologies.

The Report extends to 342 pages of letterpress, and is illustrated by 2 plates of diagrams and 52 newly constructed maps, showing the monthly and annual distribution of temperature and pressure of the atmosphere and winds over the globe. Of these 52 maps, 26 shew the mean monthly and annual temperature on hypsobathymetric maps, first on Gall's projection, and second on north circumpolar maps on equal surface projection; and 26 shew, for each month and for the year, the mean pressure of the atmosphere and the winds. The circumpolar maps shew the distribution of pressure and temperature in a manner more complete than is possible on Gall's projection, and the data thus presented is in the most serviceable form

for magnetical and other physical inquiries. From the hypsometrical data tinted on the maps, the influence of height on the distribution of pressure, temperature, and other meteorological phenomena may be noted, this influence being more particularly observed in those parts of the world whence observations from numerous stations are available. The revision of these isothermal and isobaric lines of the globe form a striking feature of the Report, and will be welcomed by all meteorologists. Mr. Buchan is in every way to be congratulated on the completion of this classic work, which must for many years to come be a standard book of reference.

Part VI.—In volume II. of the Narrative of the Cruise of H.M.S. Challenger, published in 1882, there is a detailed Statement of all the Magnetic Observations made in various parts of the world during the Expedition. These Observations, after having been reduced by the officers of the ship, were prepared for publication by Staff-Commander Creak, R.N., F.R.S., of the Hydrographic Department of the Admiralty.

A full discussion of the Challenger Observations, and their bearing on the existing state of our knowledge of Terrestrial Magnetism, not having been included in the above-mentioned Report, this Paper has been prepared, at my request, by Commander Creak.

Commander Creak had ascertained the Magnetic character of the ship previous to her departure from England in 1872, and since then all the information which has reached the Admiralty has passed through his hands.

Captain Wharton, R.N., F.R.S., the Hydrographer, having placed the whole of the data in the Hydrographic Office at his disposal, Commander Creak has been able to prepare a most valuable Report.

The accompanying Charts may be said to contain in graphic form the results of all the available existing observations of the three elements of Terrestrial Magnetism up to the year 1888, local magnetic disturbance in particular areas on land excluded.

The Report extends to 18 pages of letterpress, with 4 large charts and 2 plates.

Part VII.—This Report on the Rock Specimens collected in certain

Oceanic and other Islands visited by the Challenger Expedition necessarily deals, for the most part, with lithological or mineralogical descriptions.

The necessities of the voyage, bad weather, or the difficulties of the exploration, prevented, in many cases, the Naturalists from passing more than an hour or two on shore; they were thus unable to give any detailed account of stratigraphical relations, and the collections of hand specimens were sometimes limited to those rocks situated near the coast.

In some cases these collections can give but an imperfect idea of the lithology of the Island; still it has been considered desirable to give as full a description as possible of the specimens from regions but rarely visited, all the more so as a knowledge of the Petrology of most of these Islands has a peculiar interest, from their situation in the great ocean basins at considerable distances from continental land.

On account of the small size of many of the Islands, the author has, by combining the lithological descriptions with the local details furnished by the Naturalists, been able to give a sufficiently correct idea of the geological character of the Island under consideration. A knowledge of the principal types of rocks at certain points, shows in all probability the nature of the whole mass, when supported by observations on shore and the generally received conclusions as to the nature of Oceanic Islands.

In the case of each Island an abstract of the observations of the Naturalists is given at the head of the descriptions. These have been taken from the Narrative of the Cruise or from special papers and reports.[1] References are also given to other sources of information from the works of various geologists and travellers.

The Report consists of 180 pages, and is illustrated by 34 woodcuts, representing facts of micrographic lithology, 7 charts, and several views of the Islands extracted from the Narrative of the Cruise.

In addition to the lithological descriptions here given, there will be found a detailed Memoir by the same author on the Lithology of St. Paul's Rocks, published as Appendix B to Volume II. of the Narrative of the Cruise.

[1] Narrative of the Cruise of H.M.S. Challenger, vol. i.; J. Y. Buchanan, Preliminary Report on Geological Work done on board H.M.S. Challenger, *Proc. Roy. Soc.*, vol. xxiv. pp. 611–623; H. N. Moseley, Notes by a Naturalist on the Challenger, London, 1879; C. Wyville Thomson, The Voyage of the Challenger, The Atlantic, 2 vols., London, 1877.

The rocks described in this Report, it should be stated, do not comprise all the specimens collected during the Expedition; all those coming from well-known Islands which have been previously described, unless they should have presented special characters, have been omitted.

With the exception of a volume on DEEP-SEA DEPOSITS, which will be issued in March next, and a SUMMARY VOLUME, which, it is hoped, may be completed in about a year thereafter, the present volume concludes the Official Series of Reports on the Scientific Results of the Challenger Expedition, a complete list of which is herewith appended.

These Reports have been issued at intervals during the last nine years, whenever ready and without any reference to systematic arrangement. They are bound up in forty-seven large quarto volumes, containing 27,650 pages of letterpress, 2662 lithographic and chromo-lithographic plates, 413 maps, charts, and diagrams, together with a great many woodcuts.

I desire now to convey my thanks to the numerous contributors to this great book, as well as to all those who have in any way assisted me in, thus far, carrying on the work connected with the publication of the Scientific Results of the Expedition.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 11*th November* 1889.

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THE

VOYAGE OF H.M.S. CHALLENGER.

REPORT on some of the PHYSICAL PROPERTIES of FRESH WATER and of SEA-WATER, by Professor P. G. TAIT.

INTRODUCTION.

As I had taken advantage of the instruments employed for the determination of the *Pressure Errors of the Challenger Thermometers*[1] to make some other physical investigations at pressures of several hundred atmospheres, Dr. Murray requested me to repeat on a larger scale such of these as have a bearing on the objects of the Challenger's voyage. The results of the inquiry are given in the following paper. The circumstances of the experiments, whether favourable to accuracy or not, are detailed with a minuteness sufficient to show to what extent of approximation these results may be trusted. My object has been rather to attempt to settle large questions about which there exists great diversity of opinion, based upon irreconcilable experimental results, than to attain a very high degree of accuracy. My apparatus was thoroughly competent to effect the first, but could not without serious change (such as greatly to affect its strength) have been made available for the second purpose. The results of Grassi, Amaury and Descamps, Wertheim, Pagliani and Vincentini, &c., as to the compressibility of water at low pressures, differ from one another in a most distracting manner; and the all but universal opinion at present seems to be that, for at least five or six hundred atmospheres, there is little or no change in the compressibility, the explicit statement of Perkins notwithstanding. My experiments have all been made with a view to direct application in problems connected with the Challenger work, and therefore at pressures of at least 150 atmospheres, so that I have only incidentally and indirectly attacked the first of these questions; but I hope that no doubt can now remain as to the proper answer to the second. The study of the compressibility of various strong solutions of common salt has, I believe, been carried out for the first time under high pressures; and the effect of pressure on the maximum-density point of water has been approximated to by three different experimental methods, one of which is direct.

[1] *Narr. Chall. Exp.*, vol. ii., App. A., 1882.

CONTENTS.

COMPRESSIBILITY OF WATER, GLASS, AND MERCURY.

I. General Account of the Investigation.

I will first give a general account of the subjects treated, of the mode of conducting the experiments, and of the difficulties which I have more or less completely overcome in the course of several years' work. The reader will then be in a position to follow the full details of each branch of the inquiry.

The experiments were for the most part carried on in the large Fraser gun fully described and figured in my previous Report. But it was found to be impracticable to maintain this huge mass of metal at any steady temperature, except that of the air of the cellar in which it is placed. The great thickness of the College walls, aided by the comparative mildness of recent winters, thus limited till the beginning of the present year the available range of temperature for this instrument to that from 3° C. to about 12° C. As I did not consider this nearly sufficient, and as comparative experiments at the higher and lower of these temperatures could only be made at intervals of about six months, I procured (in May 1887) a much less unwieldy apparatus. It was made entirely of steel, so as to be of as small mass as possible, with the necessary capacity and strength: and could at pleasure be used at the temperature of the air, or be wholly immersed in a large bath of melting ice. As this apparatus was mounted, not in a cellar, but in a room sixty feet above the ground and facing the south, it enabled me to obtain a temperature range of 0° C. to 19° C., with which I was obliged to content myself. A great drawback to the use of this apparatus was found in the smallness of its capacity. Not only was I limited to the use of *two*, instead of six or seven, piezometers at a time; but the pressure could not be got up so slowly and smoothly as with the large apparatus, and (what was still worse) it could not be let off so slowly. In spite of these and other difficulties, to be detailed later, I think it will be found that the observations made with this apparatus are not markedly inferior in value to those made with the great gun.

In the piezometers I have adhered to the old and somewhat rude method of recording by means of indices containing a small piece of steel, and maintained in their positions (till the mercury reaches them and after it has left them) by means of attached hairs. These indices are liable to two kinds of deceptive displacement, upwards or downwards, by the current produced at each stroke of the pump, or by that produced

during the expansion on relief of pressure. The first could almost always be avoided, even in the smaller apparatus, provided the pressure was raised with sufficient *steadiness*, and the index brought down to the mercury at starting. But the instantaneous reaction, partly elastic, partly due to cooling, and on rare occasions due to leakage of the pump or at the plug, after a rash stroke of the pump, sometimes left the index a little *above* the mercury just before the next stroke. If another rash stroke followed, the index might be carried still farther above the point reached by the mercury. Practically, however, there is little fear of my estimates of compression having been exaggerated by this process. They are much more likely to have been slightly diminished by a somewhat sudden fall of pressure which, in spite of every care, occasionally took place at the very commencement of the relief. Once or twice the experiments were entirely vitiated by this cause; but, as we had recorded the sudden outrush *before* the plug had been removed in order to take out the piezometers, we were fully warranted in rejecting the readings taken on such an occasion:—and we *invariably* did so, whether they agreed with the less suspicious results or not.

Another and very puzzling source of uncertainty in the use of these indices depends on the fact that the amount of pressure required to move them varies from one part of the tube to another, sometimes even (from day to day) in the same part of the tube:—and the index thus records the final position of the top of the mercury column *in different phases of distortion* on different occasions. The effect of this will be to make all the determinations of compression *too small*, and it will be more perceptible the smaller the compression measured. And in sea-water, and still more in strong salt-solutions, the surface-tension of the mercury changes (a slight deposit of calomel (?) being produced), while the elasticity of the hairs also is much affected. But, by multiplying the experiments, it has been found possible to obtain what appears a fairly trustworthy set of mean values by this process.

I discarded the use of the silvering process, which I had employed in my earlier experiments,[1] partly because I found that the mercury column was liable to break, especially when sea-water was used, partly from the great labour and loss of time which the constant resilvering and refilling of the piezometers would have involved. This process has also the special disadvantage that the substance operated on is not necessarily the same in successive repetitions of the experiment.

And the electrical process[2] which I devised for recording the accomplishment of a definite amount of compression could not be employed, because it was impossible to lead insulated wires into either of my compression-chambers. This was much to be regretted, as I know of no method but this by which we can be absolutely certain of the temperature at which the operation is conducted.

My next difficulty was in the measurement of pressure. In my former Report I

[1] *Proc. Roy. Soc. Edin.*, vol. xii. pp. 223, 224, 1883.

[2] *Appendix* A to this Report.

have pointed out the untrustworthiness of the Bourdon gauges, and the uncertainty of the unit of my external gauge. This gauge was amply sufficient for all the purposes of my investigation of the errors of the Challenger thermometers, where the inevitable error of a deep-sea reading formed, according to the depth, from 5 to 20 per cent. of the pressure error; but, besides the uncertainty as to its unit, it was on so small a scale that an error of 1 per cent. in the reading, mainly due to capillary effects at the surface of the mercury column, was quite possible when the pressure did not exceed 150 atmospheres. Fortunately I was informed of the great improvement made by Amagat on the principle of the old *Manomètre Desgoffes*,—an improvement which has made it an instrument of precision instead of an ingenious scientific toy. M. Amagat was so kind as to superintend the construction of one of his instruments for me (it will be a surprise to very many professors of physics in this country to hear that the whole work was executed in his laboratory), and to graduate it by comparison with his well-known nitrogen gauge. My measurements of pressure are therefore only *one* remove from Amagat's 1000 feet column of mercury.

The change of temperature produced by compression of water is one of the most formidable difficulties I have encountered. During the compression the contents of the piezometer, as well as the surrounding water, constantly change in temperature; and the amount of change depends not only on the initial temperature of the water, but also on the rapidity with which the pressure is raised. It was impossible to ascertain exactly what was the true temperature of the water in the piezometer at the instant when the pressure was greatest, and a change of even 0°·1 C. involves a displacement of the hair index, which is quite easily detected even by comparatively rude measurement. Any very great nicety of measurement was thus obviously superfluous. My readings, therefore, were all made directly by applying to the tube of the piezometer a light but very accurate scale. The zero of this scale was adjusted to the level of the upper surface of the mercury of each piezometer the instant it was removed from the water-vessel, in which it was lifted from the pressure-chamber, and the position of the index was afterwards read at leisure. As the same scale was employed in the calibration of the piezometer tubes, its unit is, of course, of no consequence. The expansibility of water at atmospheric pressure is so small, at least up to 8° C., that no perceptible displacement of the mercury can have been introduced before the zero of the scale was adjusted to it. The effects of the raising of temperature by heating are two: a direct increase of the volume (provided the temperature be above the maximum-density point, and the pressure be kept constant), and a diminution of compressibility (provided the temperature be under the minimum compressibility point). These conspire to diminish the amount of compression produced by a given pressure. At 15° C., or so, the first of these is, in the range of my experiments, the more serious of the two, especially in the case of the solutions of common salt.

The water in the compression apparatus, even when the large one was used, slowly changed in temperature from one group of experiments to the next:—sometimes perceptibly during the successive stages of one group. The effect of this source of error was easily eliminated by means of the rough results of a plotting of the uncorrected experimental data. From this the effect of a small change of temperature on the compressibility at any assigned temperature was determined with accuracy far more than sufficient to enable me to calculate the requisite correction. This correction was therefore applied to all the experimental data of each group, for which the temperature differed from that at the commencement of the group. The corrected numbers were employed in the second and more complete graphical calculation. I endeavoured to raise the pressure in each experiment as nearly as possible by 1, 2, or 3 tons weight per square inch:—having convinced myself by many trials that this was the most convenient plan. The cure for any (slight) excess or defect of pressure was at once supplied by the graphical method employed in the reductions, in which the pressures were laid down as abscissæ, and the corresponding average compressibilities per atmosphere as ordinates.

When this work has been fully carried out, we have still only the *apparent* compressibility of the water or salt-solution. The correction for the compressibility of glass, which is by no means a negligible quantity,—being in fact about 5 per cent. of that of water at 0° C.,—involves a more formidable measurement than the other; but I think I have executed it, for two different temperatures, within some 2 per cent. or so. The resulting values of the true compressibility of water may therefore err, on this account, by 0·1 per cent. This is considerably less than the probable error of the determinations of apparent compressibility, so that it is far more than sufficient. With a view to this part of the work the piezometers, whether for water or for mercury, were all constructed from narrow and wide tubes of the same glass, obtained from one melting in Messrs. Ford's Works, Edinburgh; while solid rods of the same were also obtained for the application of Buchanan's method.[1]

My results are not strictly comparable with any that, to my knowledge, have yet been published, except, of course, those which I gave in 1883 and 1884. The reason is that the lowest pressure which I applied (about 150 atmospheres, or nearly one ton weight per square inch) is far greater than the highest employed by other experimenters, at least for a consecutive series of pressures. I must except, however, the results of Perkins and some remarkable recent determinations made by Amagat.[2] Perkins' results are entirely valueless as to the *actual* compressions, because his pressure unit is obviously very far from correct. They show, however, at one definite temperature, the rate at which the compressibility diminishes as the pressure is raised. Amagat's work, on the other hand, though of the highest order, is not yet completed by the determination of the correction for the compression of the piezometer.

[1] *Trans. Roy. Soc. Edin.*, vol. xxix. pp. 589–598, 1880. [2] *Comptes Rendus*, tom. ciii., 1886, and tom. civ., 1887.

The extension of my formulæ to very low pressures, though it agrees in a remarkable manner with some of the best of accepted results, such as those of Buchanan and of Pagliani and Vincentini, is purely conjectural, and may therefore possibly involve error, but not one of the least consequence to any inquiries connected with the problems to which the Challenger work was directed.

The piezometers, which had been for three years employed on water and on sea-water, were, during the end of last summer, refilled with solutions of common salt of very different strengths, prepared in the laboratory of Dr. Crum Brown. The determinations of compressibility were made at three temperatures only, those which could be steadily maintained, viz. 0° C., 10° C., and about 19° C., the two latter being the temperature of the room, the former obtained by the use of an ice-bath. Here great rapidity of adjustment of the scale to the mercury was requisite, even in the experiments made near 0° C., for the salt solutions (especially the nearly saturated one) show considerable expansibility at that temperature. In these salt solutions, however, the hair indices behave very irregularly; so that this part of my work is much inferior in exactitude to the rest.

Besides the determinations briefly described above, there will be found in this Report a number of experimental results connected with the effect of pressure on the temperature of water and on the temperature of the maximum density of water. Though I afterwards found that the question was not a new one, I was completely unaware of the fact when some experiments, which I made in 1881 on the heat developed by compressing water, gave results which seemed to be inexplicable except on the hypothesis that the maximum-density point is lowered by pressure. Hence I have added a description of these experiments, since greatly extended by parties of my students.

And I have appended other and more direct determinations of the change of the maximum-density point. I also give, after Canton, but with better data than his, an estimate of the amount by which the depth of the sea is altered by compression. Also some corresponding inquiries for the more complex conditions introduced by the consideration of the maximum-density point, &c.

An Appendix contains all the theoretical calculations, the results of which are made use of in the text; as well as some speculations, not devoid of interest, which have arisen in the course of the inquiry.

II. Some former Determinations.

There seems now to be no doubt that Canton (in 1762) was the first to establish the fact of the compressibility of water. But he did far more; he measured its apparent amount at each of three temperatures with remarkable accuracy, and thus discovered

(in 1764) the curiously important additional fact that it diminishes when the temperature is raised. As his papers, or at all events the second of them, seem to have fallen entirely out of notice,[1] and as they are exceedingly brief and clear, I think it well to reproduce some passages textually from the *Philosophical Transactions* of the dates given above.

"Having procured a small glass tube of about two feet in length, with a ball at one end of it of an inch and a quarter in diameter; I filled the ball and part of the tube with mercury; and, keeping it, with a Fahrenheit's thermometer, in water which was frequently stirred, it was brought exactly to the heat of 50 degrees; and the place where the mercury stood in the tube, which was about $6\frac{1}{2}$ inches above the ball, was carefully marked. I then raised the mercury, by heat, to the top of the tube, and sealed the tube hermetically; and when the mercury was brought to the same degree of heat as before, it stood in the tube $\frac{32}{100}$ of an inch higher than the mark.

"The same ball, and part of the tube being filled with water exhausted of air, instead of the mercury, and the place where the water stood in the tube when it came to rest in the heat of 50 degrees, being marked, which was about 6 inches above the ball; the water was then raised by heat till it filled the tube; which being sealed again, and the water brought to the heat of 50 degrees as before, it stood in the tube $\frac{43}{100}$ of an inch above the mark.

"Now the weight of the atmosphere (or about 73 pounds avoirdupois) pressing on the outside of the ball and not on the inside, will squeeze it into less compass.[2] And by this compression of the ball, the mercury and the water will be equally raised in the tube; but the water is found, by the experiments above related, to rise $\frac{11}{100}$ of an inch more than the mercury; and therefore the water must expand, so much, more than the mercury, by removing the weight of the atmosphere.

"In order to determine how much water is compressed by this, or a greater weight, I took a glass ball of about an inch and $\frac{6}{10}$ in diameter which was joined to a cylindrical tube of 4 inches and $\frac{2}{10}$ in length, and in diameter about $\frac{1}{100}$ of an inch; and by weighing the quantity of mercury that exactly filled the ball, and also the quantity that filled the whole length of the tube; I found that the mercury in $\frac{23}{100}$ of an inch of the tube was the 100,000 part of that contained in the ball; and with the edge of a file, I divided the tube accordingly.

"This being done, I filled the ball and part of the tube with water exhausted of air; and left the tube open, that the ball, whether in rarefied or condensed air, might always be equally pressed within and without, and therefore not altered in its dimensions.

[1] Perhaps the reason may be, in part, that by a printer's error the title of Canton's first paper is given (in the Index to vol. lii. of the *Phil. Trans.*) as "Experiments to prove that Water is not compressible."

[2] "See an account of experiments made with glass balls by Mr. Hooke (afterwards Dr. Hooke) in Dr. Birch's *History of the Royal Society*, vol. i. p. 127."

Now by placing this ball and tube under the receiver of an air-pump, I could see the degree of expansion of the water, answering to any degree of rarefaction of the air; and by putting it into a glass receiver of a condensing engine, I could see the degree of compression of the water, answering to any degree of condensation of the air. But great care must be taken, in making these experiments, that the heat of the glass ball be not altered, either by the coming on of moisture, or its going off by evaporation; which may easily be prevented by keeping the ball under water, or by using oil only in working the pump and condenser.

"In this manner I have found by repeated trials, when the heat of the air has been about 50 degrees, and the mercury at a mean height in the barometer, that the water will expand and rise in the tube, by removing the weight of the atmosphere, 4 divisions and $\frac{6}{10}$; or one part in 21,740; and will be as much compressed under the weight of an additional atmosphere. Therefore the compression of water by twice the weight of the atmosphere, is one part in 10,870 of its whole bulk.[1]

"The famous Florentine Experiment, which so many philosophical writers have mentioned as a proof of the incompressibility of water, will not, when carefully considered, appear sufficient for that purpose: for in forcing any part of the water contained in a hollow globe of gold through its pores by pressure, the figure of the gold must be altered; and consequently, the internal space containing the water, diminished; but it was impossible for the gentlemen of the Academy del Cimento to determine, that the water which was forced into the pores and through the gold, was exactly equal to the diminution of the internal space by the pressure."

"By similar experiments made since, it appears that water has the remarkable property of being more compressible in winter than in summer; which is contrary to what I have observed both in spirit of wine and oil of olives: these fluids are (as one would expect water to be) more compressible when expanded by heat, and less so when contracted by cold. Water and spirit of wine I have several times examined, both by the air-pump and condenser, in opposite seasons of the year: and, when Fahrenheit's thermometer has been at 34 degrees, I have found the water to be compressed by the mean weight of the atmosphere 49 parts in a million of its whole bulk, and the spirit of wine 60 parts; but when the thermometer has been at 64 degrees, the same weight

[1] "If the compressibility of the water was owing to *any air* that it might still be supposed to contain, it is evident that *more* air must make it *more compressible;* I therefore let into the ball a bubble of air that measured near $\frac{6}{10}$ of an inch in diameter, which the water absorbed in about four days; but I found upon trial that the water was not *more* compressed, by twice the weight of the atmosphere, than before."

"The compression of the glass in this experiment, by the equal and contrary forces acting within and without the ball, is not sensible: for the compression of water in two balls, appears to be exactly the same, when the glass of one is more than twice the thickness of the glass of the other. And the weight of an atmosphere, which I found would compress mercury in one of these balls but $\frac{1}{3}$ part of a division of the tube, compresses water in the same ball 4 divisions and $\frac{6}{10}$."

would compress the water no more than 44 parts in a million, and the spirit of wine no less than 71 of the same parts. In making these experiments, the glass ball containing the fluid to be compressed must be kept under water, that the heat of it may not be altered during the operation.

"The compression by the weight of the atmosphere, and the specific gravity of each of the following fluids, (which are all I have yet tried,) were found when the barometer was at $29\frac{1}{2}$ inches, and the thermometer at 50 degrees.

		Millionth parts.	Specific gravity.
Compression of	Spirit of Wine,	66	846
,,	Oil of Olives,	48	918
,,	Rain-Water,	46	1000
,,	Sea-Water,	40	1028
,,	Mercury,	3	13595

These fluids are not only compressible, but also elastic: for if the weight by which they are naturally compressed be diminished, they expand; and if that by which they are compressed in the condenser be removed, they take up the same room as at first. That this does not arise from the elasticity of any air the fluids contain, is evident; because their expansion, by removing the weight of the atmosphere, is not greater than their compression by an equal additional weight: whereas air will expand twice as much by removing half the weight of the atmosphere, as it will be compressed by adding the whole weight of the atmosphere.

"It may also be worth observing, that the compression of these fluids, by the same weight are not in the inverse ratio of their densities or specific gravities, as might be supposed. The compression of spirit of wine, for instance, being compared with that of rain-water, is *greater* than in this proportion, and the compression of sea-water is *less*."

With the exception of the mistake as to the non-effect of compressibility of glass, and its consequences (a mistake into which Örsted and many others have fallen long since Canton's day), the above is almost exact. The argument from the fact that thick and thin vessels give the same result is unfounded; but the discovery of the fact itself shows how accurate the experiments must have been. The formula (A) below (Section VII.), if extended to $p=0$, gives for the value of the apparent compressibility of water at 10° C. (50° F.), which is what Canton really measured, the number

$$0{\cdot}0000461,$$

exactly the same as that given by him 126 years ago!

The next really great step in this inquiry was taken by Perkins in 1826. He showed beyond the possibility of doubt that in water at 10° C. the compressibility

diminishes as the pressure is increased, quickly at first, afterwards more and more slowly.[1] This was contested by Örsted, who found no change of compressibility up to 70 atmospheres. Many other apparently authoritative statements have since been made to the same effect. Unfortunately Perkins' estimates of pressure are very inaccurate, so that no *numerical* data of any value can be obtained from his paper.

Colladon[2] is sometimes referred to as an authority on the compression of liquids. But, referring to Canton, he states that there is no difference in the compressibility of water at 0° C. and at 10° C. His words are : "Nous avons trouvé que l'eau a la même compressibilité à 0° et à + 10°. Nous avons déjà fait observer les causes d'erreur qui ont dû altérer les résultats des expériences de Canton." There can be no doubt whatever that there is a difference of 6 per cent., which is what Canton gives!

In Regnault's experiments[3] pressure was applied alternately to the outside and to the inside of the piezometer, and then simultaneously to both. From the first *Appendix* to my *Report on the Pressure-Errors*, &c., it will be seen that the three measurements of changed content thus obtained are not independent, the third giving the algebraic sum of the first two; so that, unless we had an absolutely incompressible liquid to deal with, we could not employ them to determine the elastic constants of the piezometer. For the compression of the liquid contents is added to the quantity measured, in the second and third of the experiments. Thus Regnault had to fall back on the measurement of Young's modulus, in order to obtain an additional datum. In place of this, Jamin afterwards suggested the measurement of the change of external volume of the piezometer; and this process was carried out by Amaury and Descamps. But there are great objections to the employment of external, or internal, pressure alone in such very delicate inquiries. For, unless the bulbs be truly spherical, or cylindrical, and the walls of perfectly uniform thickness and of perfectly uniform material, the theoretical conditions will not be fulfilled :—and the errors may easily be of the same order as is the quantity to be measured.

Finding that he could not obtain good results with glass vessels, Regnault employed spherical shells of brass and of copper. With these he obtained, for the compressibility of water, the value

$$0{\cdot}000048 \text{ per atm.}$$

for pressures from one to ten atmospheres. The temperature, unfortunately, is not specially stated.

Grassi,[4] working with Regnault's apparatus, made a number of determinations of compressibility of different liquids, all for small ranges of pressure.

[1] The carefully drawn plate which illustrates his paper is one of the very best early examples of the use of the graphic method. *Phil. Trans.*, vol. cvi. p. 541, 1826.

[2] *Mém. Inst. Savans Étrang.*, tom. v. p. 296, 1838.

[3] *Mém. Acad. Sci. Paris*, tom. xxi. pp. 1 *et seq.*, 1847.

[4] *Ann. de Chimie*, sér. 3, tom. xxxi. p. 437, 1851.

The following are some of his results for water :—

Temperature.	Compressibility per atm.
0°·0 C.	0·0000503
1°·5	515
4°·1	499
10°·8	480
18°·0	462
25°·0	456
34°·5	453
53°·0	441

These numbers cannot be even approximately represented by any simple formula; mainly in consequence of the maximum compressibility which, they appear to show, lies somewhere about 1°·5 C. No other experimenter seems to have found any trace of this maximum.

Grassi assigns, for sea-water at 17°·5 C., 0·94 of the compressibility of pure water, and gives

0·00000295

as the compressibility of mercury. He also states that the compressibility of salt solutions increases with rise of temperature. These are not in accordance with my results. But, as he further states that alcohol, chloroform, and ether *increase* in compressibility with rise of pressure (a result soon after shown by Amagat to be completely erroneous), little confidence can be placed in any of his determinations.

A very complete series of measurements of the compressibility of water (for low pressures) through the whole range of temperature from 0° C. to 100° C., has been made by Pagliani and Vincentini.[1] Unfortunately, in their experiments, pressure was applied to the inside only of the piezometer, so that their indicated results have to be diminished by from 40 to 50 per cent. The effects of heat on the elasticity of glass are, however, carefully determined, a matter of absolute necessity when so large a range of temperature is involved. The absolute compressibility of water at 0° C. is assumed from Grassi. The following are some of their results, showing a much larger temperature effect than that obtained by Grassi :—

Temperature.	Compressibility per atm.
0°·0 C.	0·0000503
2°·4	496
15°·9	450
49°·3	403
61°·0	389
66°·2	389
77°·4	398
99°·2	409

[1] *Sulla Compressibilità dei Liquidi*, Torino, 1884.

Thus water appears to have its minimum compressibility (for low pressures) about 63° C.

My own earlier determinations[1] will be given more fully below (Section VI.). I may here quote one or two, premising that they were given with a caution (not required, as it happens), that the pressure unit of my external gauge was somewhat uncertain. They are *true*, not *average*, compressibilities. See *Appendix* B.

	At 12°·0 C.	Ratio
Fresh water	$0{\cdot}00720\,(1-0{\cdot}034p)$	1 : 0·925
Sea water	$0{\cdot}00666\,(1-0{\cdot}034p)$	
	At 15°·5 C.	**Ratio**
Fresh water	$0{\cdot}00698\,(1-0{\cdot}05p)$	1 : 0·924
Sea water	$0{\cdot}00645\,(1-0{\cdot}05p)$	

In all of these the unit of pressure is one ton-weight per square inch (152·3 atm.). The diminution of compressibility with increased pressure was evident from the commencement of the investigations. I assumed, throughout, for the compressibility of glass

0·000386 per ton,

which, as will be seen below, is a little too small.

By direct comparison with Amagat's manometer, I have found that the pressure unit of my external gauge is too small, but only by about 0·5 per cent. This very slight underestimate of course does not account for the smallness of the pressure term of the first expression above. As will be seen later, the true cause is probably to be traced to the smallness of the piezometers which I used in my first investigations, and to the fact that their stems were cut off "square" and *dipped* into mercury. Allowing for this, it will be seen that the above estimates of compressibility agree very fairly, in other respects, with those which I have since obtained. The sea-water employed in the comparison with fresh water was collected about a mile and a half off the coast at Portobello, and was therefore somewhat less dense (and more compressible) than the average of ocean-water. In my later experiments, to be detailed below, the sea-water operated on was taken at a point outside the Firth of Forth, considerably beyond the Isle of May.

As stated in my Report on the Pressure Errors, &c., the unit of my external gauge was determined by the help of Amagat's data for the compression of air. As the piezometer containing the air had to be enclosed in the large gun, the record was obtained by silvering the interior of the narrow tube into which the air was finally compressed:—and the heating of the air by compression, as well as the uncertainty of

[1] *Proc. Roy. Soc. Edin.* 1883 and 1884.

the allowance for the curvature of the mercury, alone would easily account for the underestimate. Besides, it is to be remembered that the reading of the external gauge for 152 atm. is only about 22 mm.; so that a slight variation of surface-curvature of the mercury would of itself explain a considerable part of the half per cent. deficit. It is, however, a matter of no consequence whatever, as regards the conclusions of that Report.

Buchanan, in the paper already cited, gives for the compressibility of water at 2°·5 C. the value 0·0000516; and at 12°·5 C., 0·0000483. The empirical formula, which is one of the main results of this Report (Section VII. below), extended to $p=0$, gives 0·0000511 and 0·0000480 respectively. The agreement is very remarkable.

Amagat's[1] investigations, which were carried out by means of the electric indicator already alluded to (which informs the experimenter of the instant at which *a given amount of compression* is reached), have been extended to pressures of nearly 20 tons weight on the square inch (3000 atm.). As a preliminary statement he gives the average apparent compression (per atmosphere) of water at 17°·6 C. as follows:—

From 1 to 262 atm., ...	0·0000429,
„ 262 to 805 „	0·0000379,
„ 805 to 1334 „	0·0000332.

And he states that, at 3000 atmospheres, water (at this temperature) has lost about 1/10 of its original bulk. But Amagat has not yet published any determination of the compressibility of his glass, so that the *amount* of compression shown by his experiments cannot be compared with the results of this paper. The rate of diminution of compressibility with increased pressure, however, can be (very roughly) approximated to; and Amagat appears to make it somewhat less than I do. He operated on distilled water, thoroughly deprived of air. My experiments were made on cistern water, boiled for as short a time as possible. The analogies given in the present paper appear to show that this difference of substance operated on may perhaps suffice completely to explain the difference between our results.

I am indebted to a footnote in the recent great work of Mohn[2] for a hint which has led me to one of the most singular calculations as to the compressibility of water which I have met with. As it is given in a volume[3] whose very *raison d'être* is supposed to be the minutest attainable accuracy in physical determinations, I consulted it with eagerness. The reader may imagine the disappointment with which I found that, as regards compressibility of water, its main feature is the amazing empirical formula,—

$$501{\cdot}53 - 1{\cdot}58995t - 0{\cdot}003141113t^2 \,!$$

[1] *Comptes Rendus*, tom. ciii. p. 429, 1886, and tom. civ. p. 1159, 1887.

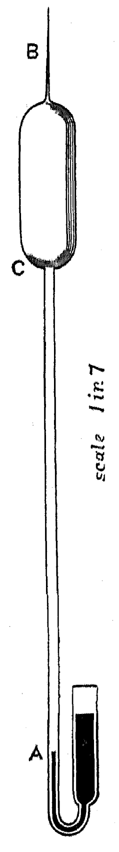
[2] Den Norske Nordhavs-Exped., Nordhavets Dybder, &c., Christiania, 1887.

[3] *Travaux et Mémoires du Bureau International des Poids et Mésures*, tom. ii. p. D30, Paris, 1883.

This formula represents a parabola which is everywhere convex upwards, and thus cannot possibly be consistent with the existence of a minimum compressibility. Instead of representing the results of new experiments, it is based on data extracted from the old and very dubious results of Grassi (two data being wrongly quoted), Descamps, and Wertheim, which differ in the wildest way from one another. What method of calculation has been employed upon this chaotic group we are not told. The result is a smug little table (D. IX.), in which no single entry can be looked upon as trustworthy! Plate II. fig. 1, shows some of the materials, as well as the final extract or quintessence derived from them.

III. The Piezometers—Reckoning of Log. Factors—Compressibility of Mercury.

The annexed sketch shows the form of piezometer employed. Six of these instruments, three filled with fresh water and three with sea-water, were simultaneously exposed to pressure. The upper end of the bulb at B was drawn out into a very fine tube, so that the instruments could be opened and refilled several times without appreciable change of internal volume. They were contained in a tall copper vessel which was let down into the pressure cylinder, and which kept them (after removal from it) surrounded by a large quantity of the press water till they could be taken out and measured one by one; each, after measurement, being at once replaced in the vessel. Large supplies of water were kept in tin vessels close to the pressure apparatus; and the temperatures of the contents of all were observed from time to time with a Kew Standard.



The stems, A C, of the piezometers were usually from 30 to 40 cm. in length, and the volumes of the cylindrical bulbs, CB, were each (roughly) adjusted to the bore of the stem, so that the whole displacement of the indices in the various vessels should be nearly the same for the same pressure. At A, on each stem, below the working portion, the special mark of the instrument was made in dots of black enamel (*e.g.* ∴, .., ⋮, &c.), so that it could be instantly recognised, and affixed to the record of the index in the laboratory book. Above this enamel mark a short millimetre scale was etched on the glass for the purpose of recording the volume of the water contents at each temperature before pressure was applied. The factor by which the displacement of the index has to be multiplied, in order to find the whole compression, varies (slightly) with the initial bulk of the water-contents. This, in its turn, depends on the temperature at which the experiment is made. Practically, it was found that no

correction of this kind need be made in experiments on fresh water between 0° and 8° C., but for higher temperatures it rapidly came into play. In the case of the stronger salt-solutions it was always required.

As an example of the general dimensions of the piezometers, I print here the details of a rough preliminary measurement of one only; and employ these merely to exhibit the nature of the calculation for the compressibility of the contents.

Measurements for (:).

21/12/86. At temperature 3° C. (:) filled with Portobello sea-water gave for

413 of gauge (about 150 atm.)	131·2 of displacement for index.
834 „ „ 300 „	256
1254 „ „ 450 „	373·6

Before pressure, mercury 20 mm. from enamel.

This experiment is selected because its data were taken for the approximate lengths of the columns of mercury used to calibrate the stem of (:).

22/6/87.

Length of col. of mercury in stem.		Weight, mercury and dish.
End 18 mm. from enamel	130·8 mm.	12·567 grm.
„ 45 „	130·8 „	Dish 9·387 „
„ 72 „	130·9 „	
„ 100 „	130·9 „	Hg. 3·180 „
„ 140 „	131·1 „	

Another column of Hg.:—

End 18 mm. from enamel	261 mm.	15·712 grm.
„ 36 „	261·1 „	9·387 „
„ 57 „	261·1 „	
„ 75 „	261·1 „	Hg. 6·325 „
„ 94 „	261·3 „	

Again another:—

End 18 mm. from enamel	372·6 mm.	18·407 grm.
„ 43 „	372·4 „	Dish 9·387 „
		Hg. 9·020 „

Weight of dish with Hg. filling bulb and stem to 599 mm. from enamel,	517·63 „
Weight of dish,	37·69 „
Hg. in piezometer, less 599 of stem,	479·94 „
Hg. in 599 of stem,	14·56 „
Whole content to enamel,	494·50 „
„ 20 from enamel,	494·0 „

The calculations are as follows,—the Gauge log. will be explained in Section IV.:—the formula is given in *Appendix* C, and the mantissæ only are written :—

log. 494 =	·69373
log. 130·8 =	·11661
(Sum)	·81034
log. 3·18 =	·50243
(Difference)	·69209
Gauge log.	·43856
(Sum)	·13065 = log. factor for pressures near 150 atm.

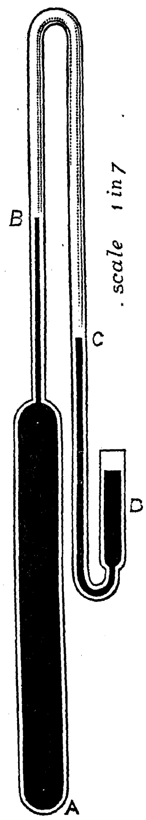
·69373	·69373
·41664	·57124
·11037	·26497
·80106	·95521
·69069	·69024
·43856	·43856
·12925 for 300 atm.	·12880 for 450 atm.

Hence apparent average compressibility of Portobello sea-water per atm. at 3° C. as given by (:) on 21/12/86 is,

For first ton . . .		·11793 = log. 131·2	
		·61595 = log. 413	
		·50198	
	log. factor	·13065	
		·63263	Antilog. = ·00004292
first two tons . .		·40824	
		·92117	
		·48707	
		·12925	
		·61632	Antilog. = ·00004134
first three tons . .		·57240	
		·09829	
		·47411	
		·12880	
		·60291	Antilog. = ·00004008

A few larger instruments were made for very accurate comparisons of fresh water and sea-water at about 1 ton weight per square inch, and at different temperatures.

The mercury contents of their bulbs, &c., were over 1000 grm. The content of 250 mm. of stem in mercury was about 7 grm.; and the log. factor, for pressures about 150 atm., nearly = 0·8.



For the compressibility of mercury, the annexed form of piezometer was employed, as in this case the recording index could not be put in contact with the liquid to be compressed. The bulb A and stem to B contain mercury, and so does the U-tube CD. Between B and C there is a column of water, whose length is carefully determined. The recording index rests on the mercury column at C. Thus, obviously, its displacement is due to

Compression of mercury A B + Compression of water B C − Compression of vol. of glass vessel from A to C.

The measurements of this apparatus are :—

MERCURY PIEZOMETER. 25/7/87.

Hg. and vessel,	1100	grm.
Vessel,	37·7	„
Weight of mercury whose compression is measured,	1062·3	„
Hg. and dish,	14·412	„
Dish,	9·386	„
Weight of mercury in 210 mm. of tube B C,	5·026	„
Length of water column B C,	286 mm.	

The observations made with this apparatus were as follows, the results calculated being added, enclosed in square brackets :—

22/6/86. Kew Standard, 12°·75.
Alteration of Index, 17 mm.
Gauge pressure, 811
[Apparent compressibility, 0·00000102]

24/6/86. K. S. 12°·4.
Index, 17
Pressure, 833
[0·00000098]

25/6/86. K. S. 12°·3.

Index,	18·5	26·0	26·0
Pressure,	834	1252	1257
	[0·00000109]	[102]	[101]

23/7/87. K. S. 1°·2.

Index,	7·3	17·3	25
Pressure,	436	865	1264
	[0·00000074]	[94]	[93]

25/7/87. K. S. 16°·5.

Index,	9	16·6	25
Pressure,	459	866	1271
	[0·00000093]	[92]	[95]

The range of temperature is quite sufficient to allow a change of compressibility of the water column to be noted; but the experiments unfortunately do not enable us to assert anything as to a change in that of mercury; though, were it not for the last set of experiments, there would appear to be a decided *increase* of compressibility of mercury with rise of temperature. The experiments are only fairly consistent with one another; but this was noted at the time as the fault of the index, which, of course, tells more as the quantity measured is less. It may be as well to show how to deduce the compressibility of mercury from them at once, assuming the requisite data for water and for glass from subsequent parts of the Report.

Take, for instance, the first result of 25/6/86. 834 of gauge is about 305 atmospheres. Also shortening of 286 mm. of water column (in glass) at 12°·3 C by 305 atm. = 3·7 mm. nearly:—so that the compressed mercury apparently loses about the content of 14·8 mm. of narrow tube = bulk of 0·354 grm. Hg.

$$\text{Apparent compressibility} = \frac{0{\cdot}354}{305 \times 1062{\cdot}3} = 0{\cdot}00000109$$

The average of all the normal experiments gives 0·000001 very nearly.

Add compressibility of glass = 0·0000026

Compressibility of mercury = 0·0000036

It is well to remember that though Grassi, working with Regnault's apparatus, gave as the compressibility of mercury

0·00000295

which Amaury and Descamps afterwards reduced to

0·00000187,

the master[1] himself had previously assigned the value

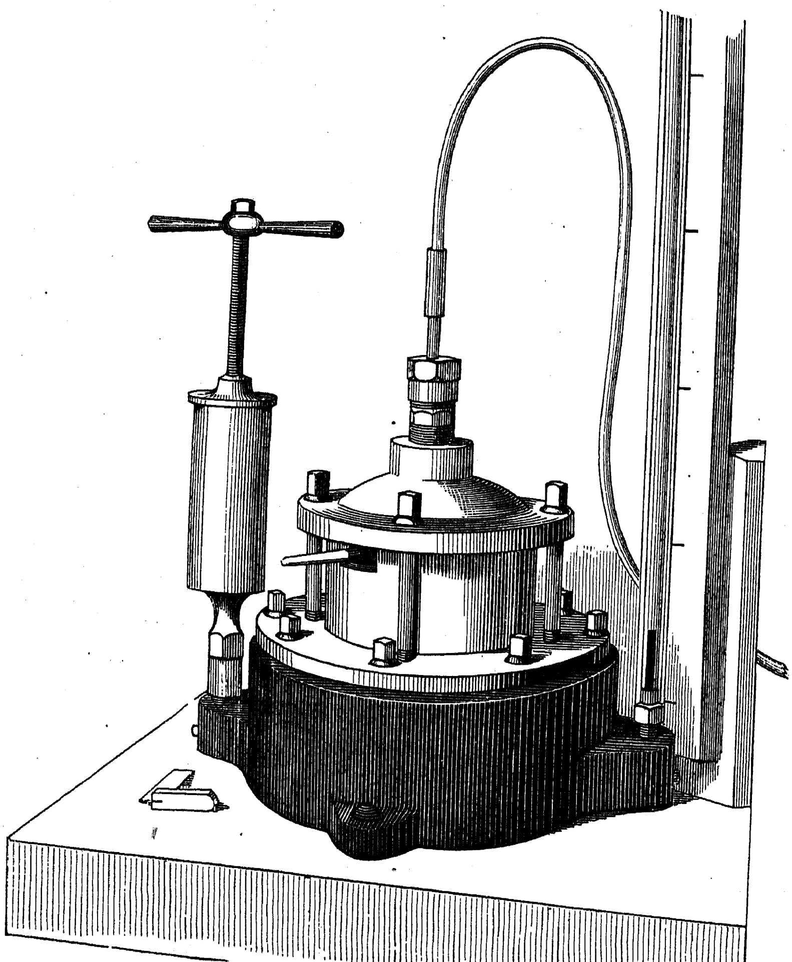
0·00000352.

Had Grassi's result been correct, I should have got only about half the displacements observed; had that of Amaury and Descamps been correct, the apparent compressibility would have had the *opposite sign* to that I obtained, so that the index would not have been displaced. In such a case the construction of the instrument might have been much simplified, for the index would have been placed in contact with the mercury at B, and the bent part of the tube would have been unnecessary.

[1] Rélation des Expériences, &c., *Mém. Acad. Sci. Paris*, tom. xxi. p. 461, 1847.

IV. Amagat's Manomètre à Pistons libres.

The annexed sketch of the instrument (in which the large divisions shown on the manometric scale correspond to decimetres), with the section given below, will enable



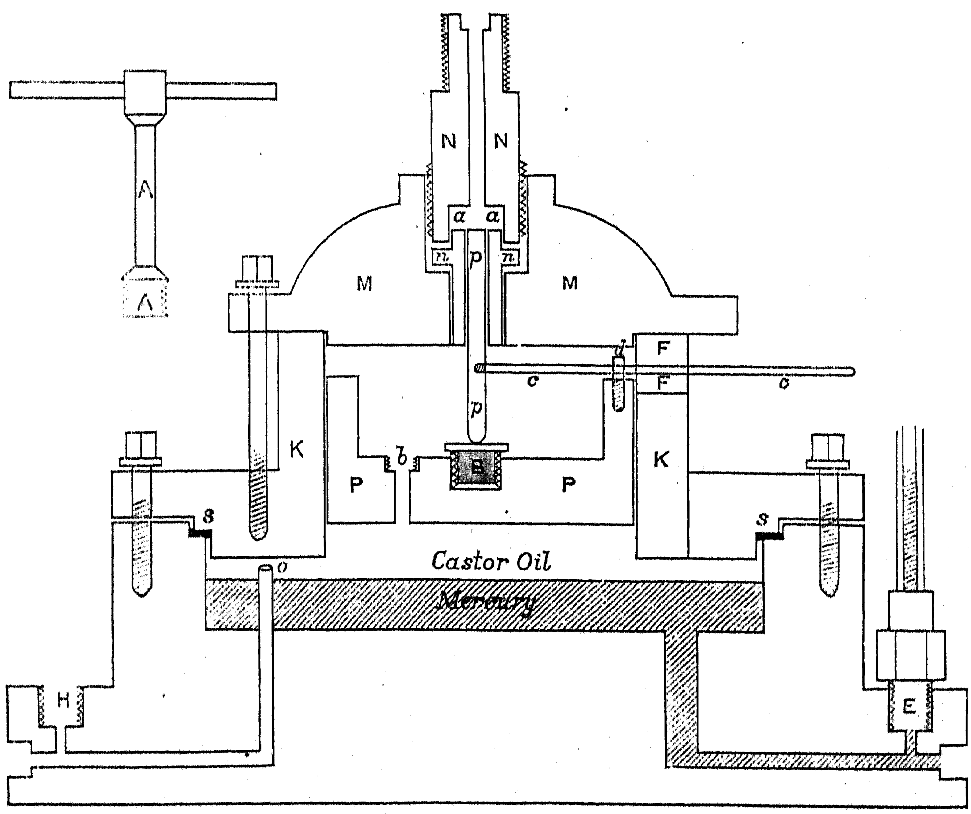
the reader to understand its size and construction without any detailed description beyond what is given in the instructions for setting it up. [The window FF, whose position is nearly immaterial, occupies different positions in the sketch and in the section.]

As already stated, the principle on which this instrument works is the same as that of the *Manomètre Desgoffes*, a sort of inverse of that of the well-known *Bramah Press*. In the British instrument pistons of very different sectional area are subjected

to the same pressure (that of one mass of liquid), and the total thrust on each is, of course, proportional to its section. In the French instrument the pistons are subjected to *equal* total thrusts, being exposed respectively to fluid pressures which are inversely proportional to their sections. The British instrument is employed for the purpose of overcoming great resistances by means of moderate forces; the French, for that of measuring great pressures in terms of small and easily measurable pressures.

Amagat's notable improvement consists in dispensing with the membrane, or sheet of india-rubber, which was one of the main features of the old Desgoffes manometer, and making his large, as well as his small, piston, fit *all but tightly* the hollow cylinders in which they play :—a very thin layer of viscous fluid passing with extreme slowness between each piston and its cylinder. The adjustment is very prompt, even in winter when the viscosity of the fluids is greatest :—but it is made almost instantaneous by a simple but ingenious device, which enables the operator to give the pistons a simultaneous motion of rotation. The following directions which accompanied the instrument will enable the reader fully to understand its construction and use. I have given an accurate *version*, not a literal *translation*, of them :—

"*Process of setting up the Apparatus.*



"1. Screw in, at E, the manometer tube, and at H the regulating pump.

"2. Pour in the layer of mercury, and on it that of castor oil. Fill the pump with glycerine, and insert its piston, taking care to exclude air-bubbles.

"3. Insert the gun-metal part K. Its bearing (at *s*) on the rim of the cast-iron base-piece must not be made with leather, but with a ring of india-rubber, or of very uniform cardboard. The fixing down of this part, by means of the (six) screws, must be done with great exactness:—otherwise (thick as it is) it might suffer a very slight distortion, and the piston PP would not work in it.

"4. After pouring in, if necessary, some more castor oil, insert *very cautiously* the piston PP, carefully wiped, and then anointed with castor oil. To put it in, it is to be held by means of A, which, for this purpose, is screwed into the middle of it. During the insertion of the piston the hole *b* is left open to allow of the escape of air and (possible) excess of castor oil. Close *b* by means of its screw, the piston being held at the desired height. Take out A, and screw B into the piston in place of it.

"5. Put on the part MM—after inserting in it the small piston *pp*, with its cylinder *nn*—in such a way that the rod *cc* may pass between the two studs *d* on the piston PP, opposite to the opening FF.

"6. Pour a little treacle over the small piston at *aa*; screw on the piece NN, and fill it with glycerine; then adjust to NN the coupling-tube of the compression apparatus, which should be filled with glycerine or with glycerine and water.

"*Observations.*

"It is not necessary that the whole space between the mercury and the piston PP should be filled with castor oil. A layer of glycerine and water may be placed over the mercury, then a thin layer of the oil. In fact, the regulating pump is full of glycerine and water.

"The rod *cc* is placed as shown to give a simultaneous rotation to the two pistons, so as to overcome stiction.

"It should be moved slowly, and in such a way as to exert no vertical force upon the piston PP. It ought to be pushed by a vertical straight-edge, moved horizontally. One can judge of the delicacy of the apparatus by the displacement of the mercury column when the slightest vertical pressure is exerted on the rod.

"I will again call attention to the scrupulous care which must be bestowed on the pistons and on the cylinders in which they work:—the slightest scratch, due to dust, would make it necessary to retouch these surfaces; and after several retouchings they will become too loose.

"The manometer tube, which is to be cemented into the iron piece which screws into E, should be chosen of small enough diameter to prevent sensible change of level

of the mercury in the reservoir, and yet not so narrow as to prevent free motion of the mercury.

"*Important Remark.*—During the successive operations the large piston should always, by means of the regulating pump, be kept at such a height that the rod *cc* shall not come in contact with the wall of the opening FF, and not high enough to make the wide lower part of the small piston come against the piece M (this, of course, when the smaller of the two upper pistons is used :—that whose lower part is thickened).

"There are two pistons *pp* for this manometer. The ratio of the section of the larger to that of PP is 1/61·838, and the reading per atmosphere is 12·290 mm.

"For the smaller, the ratio of the sections is 1/277·75, and the reading per atmosphere is 2·736 mm.

"The former serves for the measurement of lower pressures, up to the point at which the oil passes visibly round the large piston. For higher pressures the latter must be used.

"The treacle must be changed from time to time; first, because, after a while, some of it passes the small piston; second, because it gradually dissolves in the glycerine, and at last becomes hardened round the small piston, so as to make the friction too great. The small piston and its cylinder should occasionally be cleaned with the greatest care, and anointed with neats-foot oil."

In all my later experiments I have used exclusively the smaller of the two small pistons. The scale which I fitted to the manometer tube was a long strip of French plotting paper. It had shrunk slightly, so that 752·5 divisions corresponded to 750 mm. Neglecting the difference in the values of gravity at Lyons and at Edinburgh, the number of scale divisions per atmosphere is $2{\cdot}736 \times 752{\cdot}5/750$; and its logarithm, *i.e.* the Gauge Log. above spoken of, is ·43856.

V. Compressibility of Glass.

Buchanan's process, already referred to, consists simply in measuring the fractional change of length of a glass rod exposed to hydrostatic pressure, and trebling the linear compressibility thus determined. The only difficulty it presents is that of directly measuring the length of the rod while it is under pressure. I employed a couple of reading microscopes, with screw-travelling adjustment, fixed to the ends of a massive block of well-seasoned wood. This block was placed over the tube containing the glass rod, but quite independently,—the two distinct parts of the apparatus being supported separately on the asphalt floor of a large cellar. No tremors were perceptible except when carriages passed rapidly along the wooden pavement of the street, and even then they were not of much consequence.

The ends of the tube containing the rod must, of course, be made of glass, or some other transparent material. In the first apparatus which I used, tubes of soda-water-bottle glass were employed, their bore being about 0·2 inch, and the thickness of the walls about 0·3 inch. The image of the small enamel bead at the end of the glass rod was very much distorted when seen through this tube, but the definition was greatly improved by laying on it a concavo-plane cylindrical lens (which fitted the external curvature), with a single drop of oil between them. I found, by trial, that, had it been necessary to correct for the internal curvature also, the employment of winter-green (or *Gaultheria*) oil as the compressing liquid would have effected the purpose completely:—the refractive index being almost exactly the same as that of the green glass.

As the construction and mode of support of this apparatus did not enable us completely to get rid of air from its interior, there were occasional explosions of a somewhat violent character when the glass tubes gave way; and the operators who were not otherwise protected (as by the microscopes, for instance) were obliged to hold pieces of thick plate glass before their eyes during the getting up of pressure. The explosions not only shattered the thick glass tube into small fragments, but smashed the ends of the experimental glass rod, so that a great deal of time was lost after each. Only on one occasion did we reach a pressure of 300 atm., and an explosion occurred before the measurement was accurately made. On these accounts, after four days experimenting (the first being merely preliminary), we gave up working with this apparatus:—and the results obtained by means of it cannot be regarded as wholly satisfactory, though they agreed very well with one another.

As a sudden shock might have injured the Amagat gauge, all the pressures were measured by the old external gauge, whose unit is now determined with accuracy. Hence the readings are in tons-weight per square inch (152·3 atm.), which are below called "tons" as in the vernacular of engineers. Three of us at least were engaged in each experiment, one to apply and measure the pressure, and one at each microscope. Pressure, in each group of experiments, was applied and let off six or seven times in succession, readings of the two microscopes being taken before, during, and after each application of pressure. To get rid of the possible effects of personal equation, the observers at the microscopes changed places after each group of experiments (sometimes after two groups), so that they read alternately displacements to the right and to the left.

The values of the screw-threads were carefully verified upon one of the subdivisions of the scale which was employed to measure the length of the experimental rod; these subdivisions having been since tested among themselves by means of a small but very accurate dividing-engine of Bianchi's make.

These experiments were made in July 1887, when the day temperature of the room was nearly 20° C. In the last two groups the compression tube was surrounded

in great part by a jacket containing water and pounded ice. We had no means of ascertaining the average temperature of the glass rod, but it cannot have been more than some 5 or 6 degrees above 0° C. This was done merely to ascertain whether glass becomes less compressible or no as the temperature is lowered, not the *amount* of change. The question appears to be answered in the affirmative.

Early in the present year Mr. Buchanan kindly lent me his own apparatus, which is in three respects superior to mine. (1) A longer glass rod can be operated on. (2) The air can be entirely got rid of from the interior, so that when the glass tubes give way there is no explosion. (3) The glass tubes are considerably narrower in bore (though with equal proportionate thickness), and consequently stronger. I used my own pump and external gauge, but the necessary coupling pieces were easily procured; and the reading-microscopes were fastened to a longer block of seasoned wood than before. These experiments have been made near one temperature only, but it is about the middle of the range of temperatures in my experiments on water and sea-water.

It is not necessary to print the details of the experiments in full. I give below part of a page of the laboratory book for a single day's work, to show how far the experiments of one group agree with one another. I purposely choose one in which the glass rod was somewhat displaced in the apparatus during the course of the measurements:—

23/2/88. Kew Standard, 9°·1 C.

(Length of glass rod, 75·75 inches.)

External Gauge (Lindsay).		Right Microscope (Nagel).	Left Microscope (Peddie).	Contraction and Elongation.
		in.	in.	
41·5	22 = 1 ton	0·4570	0·3377	0·0099
63·5		475	3	0·0099
41·5		570	7	
41·5	22	0·4571	0·3377	0·0102
63·5		473	3	0·0102
41·5		572	6	
41·5	22	0·4572	0·3376	0·0103
63·5		473	2	0·0103
41·5		572	6	
		(Peddie.)	(Nagel.)	
42	22	0·4566	0·3380	0·0100
64		469	77	0·0101
42		574	73	
42	22	0·4575	0·3373	0·0105
64		475	68	0·0104
42		574	73	
42	22	0·4574	0·3374	0·0103
64		475	70	0·0102
42		574	73	
			Mean, .	0·0102

The mean thus obtained coincided very closely with the mean of all the experiments. Hence the average linear compressibility per atmosphere for the first ton is, at 9°·1 C.,

$$\frac{0{\cdot}0102}{152{\cdot}3 \times 75{\cdot}75} = 0{\cdot}000000884$$

whence the compressibility of glass is

$$0{\cdot}00000265$$

The two series of experiments agreed fairly with one another, and appeared to show an increase of compressibility with rise of temperature, and a diminution with rise of pressure, but these are not made certain. Considerably greater ranges, both of pressure and of temperature, are necessary to settle such questions.

As I cannot trust to a unit or two in the last place, (*i.e.* the seventh place of decimals), my results for the apparent compressibility of water, and as an error of reading of the external gauge may easily amount to 1 per cent. of the whole ton applied, I have taken from the above experiments the number 0·0000026 as expressing with sufficient accuracy the compressibility of the glass of the piezometers *throughout* the range of temperature 0° to 15° C., and of pressure from 150 to 450 atm. This number is simply to be *added* to all the values of apparent compressibility. Had I pushed the pressures farther than 450 atm., this correction would have required reduction, as shown in *Appendix* D.

VI. Résumé of my own Experiments on Compression of Water and of Sea-Water.

The following details are, where not otherwise stated, taken from my laboratory books. I was led to make these experiments by the non-success of an attempt to determine the exact unit of the external gauge (described in my former Report). Not being aware of the great discovery of Canton (in fact, having always been accustomed to speak of *the* compressibility of water as 1/20,000 per atm.), I imagined that I could verify my gauge by comparing, on a water piezometer, the effects of a pressure measured by the gauge with those produced by a measured depth of sea-water, without any reference to the temperatures at which measurements were made; provided, of course, that these were not very different. The result is described in the following extract :[1]—

"To test by an independent process the accuracy of the unit of my pressure gauge, on which the estimated corrections for the Challenger deep-sea thermometers depend, it was arranged that H.M.S. 'Triton' should visit during the autumn a region in which soundings of at least a mile and a half could be had. A set of manometers, filled with pure water, and recording by the washing away of part of a very thin film of silver,

[1] *Proc. Roy. Soc. Edin.*, vol. xii. pp. 45, 46, 1882.

were employed. They were all previously tested, up to about $2\frac{1}{2}$ tons weight per square inch, in my large apparatus. As I was otherwise engaged, Professor Chrystal and Mr. Murray kindly undertook the deep-sea observations; and I have recently begun the work of reducing them.

"The first rough reductions seemed to show that my pressure unit must be somewhere about 20 per cent. too small. As this was the all but unanimous verdict of fifteen separate instruments, the survivors of two dozen sent out, I immediately repeated the test of my unit by means of Amagat's observed values of the volume of air at very high pressures. The result was to confirm, within 1 per cent., the accuracy of the former estimate of the unit of my gauge. I then had the manometers resilvered, and again tested in the compression apparatus. The results were now only about 5 per cent. different from those obtained in the 'Triton.' There could be no essential difference between the two sets of home experiments, except that the first set was made in July, the second in November,—while the temperatures at which the greatest compressions were reached in the 'Triton' were at least 3° C. lower than those in the latter set. Hence it seems absolutely certain that water becomes considerably more compressible as its temperature is lowered, at least as far as 3° C. (the 'Triton' temperature). This seems to be connected with the lowering by pressure of the maximum density point of water,[1] and I intend to work it out. It is clear that in future trials of such manometers some liquid less anomalous than water must be employed.

"Another preliminary result, by no means so marked as the above, and possibly to be explained away, is that by doubling (at any one temperature) a high pressure we obtain somewhat less than double the compression. This, however, may be due to the special construction of the manometer, which renders the exact determination of the fiducial point almost impossible."

In the winter of 1882 and the succeeding spring, I spent a great deal of time in trying to get definite results from the records of the "Triton" trials, and in making further experiments on those of the specially prepared piezometers which had not been broken or left at the bottom of the sea. But this work led to no result on which I could rely. I then directly attacked the problem of the compressibility of water at different temperatures and pressures, having once more verified the unit of my pressure gauge by comparison with Amagat's data for air. Results for one temperature were published, as below, in the Proc. Roy. Soc. Edin., vol. xii. pp. 223, 224, 1883. [The mercury content of the bulbs of the new piezometers was about 200 grm., and that of 100 mm. of stem about 2·6 grm.]

"The apparatus employed was of a very simple character, similar to that which was used last autumn in the 'Triton.'

[1] [The reason for this remark will be seen in the second extract in Section XII. below. 20/6/88.]

"It consisted of a narrow and a wide glass tube, forming as it were the stem and bulb of a large air-thermometer. The stem was made of the most uniform tube which could be procured, and was very accurately gauged; and the weight of the content of the bulb in mercury was determined. Thus the fraction of the whole content, corresponding to that of one millimetre of the tube, was found.

"This apparatus had the interior of the narrow tube very carefully silvered; and while the whole, filled with the liquid to be examined, was at the temperature of the water in the compression apparatus, the open end was inserted into a small vessel containing clean mercury. Four instruments of this kind were used, all made of the same kind of glass. [They were numbered, as in the headings of the columns below, 1, 2, 3, 4, respectively. 20/6/88.]

"The following are the calculated apparent average changes of volume per ton weight of pressure per square inch (*i.e.* about 150 atmospheres):—

FRESH WATER, at 12° C.

Pressure	1	2	3	4	Mean.
1	0·00670	*	665	666	0·00667
2	0·00657	*	646	656	0·00653
2·5	0·00651	650	640	648	0·00647
3	0·00641	633	636	636	0·00636

NOTE.—The first two experiments with No. 2 failed in consequence of a defect in the silvering.

The compressibility of glass was not directly determined. It may be taken as approximately 0·000386 per ton weight per square inch.

"From these data, which are fairly consistent with one another, we find the following value of the *true* compressibility of water per ton, the unit for pressure (p) being 1 ton-weight per square inch, and the temperature 12° C.,

$$0{\cdot}0072\ (1 - 0{\cdot}034\ p);$$

showing a steady falling off from Hooke's Law.

SEA-WATER, at 12° C.

Pressure	1	2	3	4	Mean.
1	0·00606	611	615	627	0·00615
2	0·00595	607	598	601	0·00600
2·5	0·00600	600	594	590	0·00594
3	0·00588	593	586	586	0·00588

NOTE.—The sea-water employed was collected about 1½ miles off the coast at Portobello.

These give, with the same correction for glass as before, the expression

$$0{\cdot}00666\ (1 - 0{\cdot}034\ p).$$

Hence the relative compressibilities of sea and fresh water are about

$$0{\cdot}925\,;$$

while the rate of diminution by increase of pressure is sensibly the same ($3\frac{1}{2}$ per cent. per ton weight per square inch) for both.

"With the same apparatus I examined alcohol, of sp. gr. 0·83 at 20° C.

ALCOHOL, at 12° C.

Pressure	1	2	3	4	Mean.
1	0·01202	1193	*	*	0·01200
2·5	0·01040	1052	1050	1056	0·01049
3	0·01043	1050	1043	1058	0·01048

These experiments were not so satisfactory as those with water. There are peculiar difficulties with the silver film. I therefore make no definite conclusion till I have an opportunity of repeating them."

It will be observed that the diminution of compressibility as the pressure is raised is here brought out unequivocally for all the three liquids examined.

In the course of another year I had managed to obtain similar results for a range of temperature of about 9° C. They were described in Proc. Roy. Soc. Edin., vol. xii. pp. 757, 758, 1884, as follows :—

"I had hoped to be able, during the winter, to extend my observations to temperatures near the freezing point, but the lowest temperature reached by the large compression apparatus was 6°·3 C.; while the highest is (at present) about 15° C. From so small a range nothing can be expected as to the temperature effect on the compressibility of water, further than an approximation to its values through that range.

"The following table gives the mean values of the average compression per ton weight per square inch :—

Pressure in Tons.	1	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4
6°·3 C.	0·00704	692	684	672	...	...
7°·6	...	682	...	670	660	...
11°·3	684	670	...	654	...	...
13°·1	...	666	...	648	...	637
15°·2	673	654	...	633	...	...

"These are all *fairly* represented by the expression

$$0{\cdot}00743 - 0{\cdot}000038\,t - 0{\cdot}00015\,p,$$

where t is the temperature centigrade, and p the pressure in tons weight per square inch. This, of course, cannot be the true formula, but it is sufficient for ordinary purposes within the limits of temperature and pressure above stated. It represents the value of

$$\frac{v_0 - v}{pv_0}.$$

"With a new set of compression apparatus, very much larger and more sensitive than those employed in the above research, I have just obtained the following mean values for the single temperature 15°·5 C.:—

Pressure in Tons.	1	$1\frac{1}{2}$	2	3
Fresh water, . . .	0·00678	663	657	638
Sea-water, . . .	0·00627	618	609	593

"These are the values of $\frac{v_0 - v}{pv_0}$, and they give, for the true compressibility $\left(-\frac{1}{v}\frac{dv}{dp}\right)$[1] at any pressure, and temperature 15°·5 C., the formulæ,

Fresh water, ...	$0·00698(1 - 0·05\,p)$
Sea-water, ...	$0·00645(1 - 0·05\,p)$

"The ratio is 0·925, *i.e.* the compressibility of sea-water at the above temperature is only 92·5 per cent. of that of fresh water."

The new and larger piezometers referred to were made when Mr. Murray requested me to write this Report. They are those whose form and dimensions have been detailed in Section III. above. The former piezometers had no capsule containing mercury, but had the stem simply cut off flat at the end, and when filled with water were merely dipped in mercury. I had felt that to this was probably due the fact that my experiments gave a value of the compressibility at 0° C. somewhat smaller than that usually accepted. It will be seen that the very first data given by the new instruments at once tended to set this matter right. For while the formula representing the results of the smaller instruments gave the compression of water at 15°·5 C. as 0·00678 for one ton weight per square inch, that for those of the new instruments gave 0·00698, *i.e.* about 1/34th more, which is much nearer to the result of my later experiments.

For two winters after this period the apparatus was kept in working order in the hope that I might be enabled to employ temperatures between 6° and 0° C. But a single day's work at 1°·7 C., and a few days at temperatures between 3° and 5° C. were all I got. Hence the reason for procuring the smaller compression apparatus, as stated in Section I. But, as yet, my measurements of pressure were not satisfactory.

In the spring of 1886 I obtained the Amagat gauge, and after a careful compara-

[1] [See *Appendix* B to this Report.]

tive trial determined to employ exclusively the lesser of the two small pistons. Some time was spent upon a comparison of the indications of this instrument with those of the external gauge, with the result that single indications of the latter could not be trusted within about 1 per cent., though the mean of a number of observations was occasionally very close to the truth. I therefore put aside all the compression observations already made, and commenced afresh with the same piezometers as before, and with the Amagat gauge exclusively.

In the summer of 1886 I obtained a long series of determinations at about 11°·8 C., and others at 14°·2 and 15° C. In December of the same year I worked for a long time between 3° and 3°·5 C. All of these were with the large Fraser gun.

In June 1887, with the new compression apparatus, I secured numerous determinations at 0°·4 C.

In July the piezometers were filled with solutions of salt of various strengths, and examined at temperatures near 19° C. and 1° C. In November these were again examined, this time in the large gun at about 9° C.; and the piezometers were again filled, some with fresh water and some with sea-water.

During the winter complete series of observations in the large gun were obtained at about 7°, 5°, 3°·2, 2°·3, 1°·1; and, finally (on March 16, 1888), at 0°·5 C.

The piezometers were, once more, filled with the salt solutions, as I considered that I had obtained sufficient data for fresh water and for sea-water; except in the one important particular of the exact values of the *ratio* of their compressibilities at one or two definite temperatures and pressures.

These were finally obtained in May and June 1888, with piezometers considerably larger and more delicate than the former set.

VII. Final Results and Empirical Formulæ for Fresh Water.

Although my readings and calculations were throughout carried to four significant figures, I soon found that (for reasons already sufficiently given in Section I.) only three of these could be trusted even in the average of a number of successive experiments, and that the third might occasionally (especially with sea-water) err by an entire unit or two; at most ½ per cent. of the whole quantity measured. Of course, now and then there occurred results so inconsistent with the rest as to indicate, without any doubt, a displacement of the index by upward or (more frequently) downward currents.

This was made obvious by comparison of the indications of any one piezometer in successive experiments at the same temperature and pressure; but it was even more easily seen in the relative behaviour of a number of piezometers which were simultaneously exposed to exactly the same temperature and pressure several times in

succession. A single page of my laboratory book, taken at random, sufficiently illustrates this. To avoid confusion, I give the records of two of the ordinary instruments (with fresh water) alone, leaving out the records of those with sea-water, and I insert [in brackets] the pressures and the average apparent compressibilities calculated from the data. The water employed was that of the ordinary supply of Edinburgh, and was boiled, for a short time only, to expel air :—

	23/7/86.				
I.	E. G.	A. G.	2 c.		[Pressure 0·983 tons]
	25·0	8		∴ 136·2	[4333]
	46·4	419	28·0	.. —	—
	25·0	8			
		K. S. (in gun) 14°·9 C.			
II.					
	25·1	8			[0·993]
	47·0	423	28·0	∴ 137·7	[4339]
	25·1	8		.. 122·5	[4342]
		K. S. 15°			
III.					
	25·1	8			[1·992]
	68·1	841	56·0	∴ 269·0	[4218]
	25·1	8		.. 256·6	[4214]
		K. S. 15°			
IV.					
	25·2	8			[2·0]
	68·4	844	56·0	∴ 269·8	[4216]
	25·2	8		.. 258·1	[4224]
V.					
	25·2	8			[2·997]
	90·0	1261	85·0	∴ 393·7	[4092]
	25·5	8		.. 376·9	[4116]
		K. S. 15°			
VI.					
	25·6	8			[3·002]
	90·0	1263	85·0	∴ 394·4	[4093]
	25·5	8		.. 376·9	[4110]

The left-hand column gives the readings of the external gauge, the next those of Amagat's gauge, before, during, and after the application of pressure. The third gives the pressure as read by one of the internal gauges described in my previous Report. The fourth column gives the readings of the two piezometers selected; the fifth the pressure (in tons) for each experiment, and the compressibility calculated. The latter numbers are multiplied by 10^8.

Notice that, in the first experiment (..) failed to give a reading. Also in the fifth and sixth the indications of the two instruments do not agree very closely. The character of the results, however, points apparently to an error in gauging one or other of the instruments. It was the unavoidable occurrence of defects of these kinds that led me to make so many determinations at each temperature and pressure selected. The above specimen contains less than 1 per cent. of my results for fresh water, and I obtained at least as many reduced observations on sea-water.

To obtain an approximate formula for the full reduction of the observations, I first made a graphic representation, on a large scale, of the results for different pressures at each of four temperatures, adding the compressibility of glass as given in Section VI. above. From this I easily found that the average compressibility for 2 tons pressure (at any one temperature) is somewhat *less* than half the sum of those for 1 and for 3 tons. Thus the average compressibility through any range of pressure falls off more and more slowly as that range is greater. And, within the limits of my experiments, I found that this relation between pressure and average compressibility could be fairly well represented by a portion of a rectangular hyperbola, with asymptotes coincident with and perpendicular to the axis of pressure. Hence at any one temperature (within the range I was enabled to work in), if v_0 be the volume of fresh water at one atmosphere, v that under an *additional* pressure p, we have

$$\frac{v_0-v}{pv_0}=\frac{A}{\Pi+p}$$

very nearly, A and Π being quantities to be found.

I had two special reasons (besides, of course, its adaptability to the plotted curve) for selecting this *form* of expression. *First*, it cannot increase or diminish indefinitely for increasing positive values of p, and is therefore much to be preferred in a question of this kind to the common mode of representation by ascending powers of the variable, such as two or more terms of

$$B_0+B_1p+B_2p^2+ \text{\&c.},$$

or the absolutely indefensible expression, too often seen in inquiries connected with this and similar questions,

$$C_0+C_1p^{\frac{m}{n}}+ \text{\&c.}$$

Second, it becomes zero when p is infinite, as it ought certainly to do in this physical problem. It appeared also to suggest a theoretical interpretation. But I will say no more about this for the present, as it is simply a matter of speculation. See the latter part of Section X., below. But there is a grave objection to this form of expression, in the fact that small percentage changes in the data involve large percentage changes in A and Π, though not in the ratio A/Π. This objection, however, does not apply to

the use of it in the calculations preliminary to the full reduction, as in them it is A/Π only which is required.

Next, on calculating from my data the values of A and Π for different temperatures, I found that, within the recognised limits of errors of the observations, Π might be treated as sensibly constant. Thus I was enabled easily to make graphic representations of the average compressibility at each pressure, in terms of temperature. Again I obtained curves which could, for a first trial at least, be treated as small portions of rectangular hyperbolas, with the axis of temperature as one asymptote. Hence

$$A = \frac{B}{T+t}$$

where T is a constant; and B also may for a time be treated as constant.

Thus I arrived at the empirical expression

$$\frac{B}{(\Pi+p)\,(T+t)}$$

whose simplicity is remarkable, and which lends itself very readily to calculation. As I required it for a temporary purpose only, I found values of the constants by a tentative process; which led to the result

$$\frac{0{\cdot}28}{(36+p)\,(150+t)}$$

This gives the *average compressibility per atmosphere* throughout the range of additional pressure p, the latter being measured in tons' weight per square inch.

The following brief table shows with what approximation the (unreduced) experimental results (multiplied by 10^7) are represented by this formula. The *nearest* integer is taken in the third place:—

	1 ton.			2 tons.			3 tons.		
Temp.	Obs.	Calc.	D.	Obs.	Calc.	D.	Obs.	Calc.	D.
0°·4	503	503	0	489	490	−1	477	477	0
3°·2	492	494	−2	479	481	−2	466	469	−3
11°·8	467	468	−1	454	455	−1	441	444	−3
15°·0	459	459	0	448	447	+1	436	435	+1

The agreement is tolerably close, so that the empirical formula may be used, without any great error, in the hydrostatic equations, so long as the temperatures and pressures concerned are such as commonly occur in lakes.

But the columns of differences show that the *form* of the formula is not suitable. The pressure factor seems appropriate, but it is clear that, at any one pressure, the curve representing the compression in terms of the temperature has greater curvature than the formula assigns. Still the formula amply suffices for the reduction of the observations of any one group when the pressures or temperatures were not precisely

the same in all. It was, however, not much required, for the pressure could be adjusted with considerable accuracy, and (especially when the large gun was used) the changes of temperature were very slow.

The next step was to enter, as shown in Plate II. fig. 3, *all* the results obtained from the various piezometers at each definite temperature and pressure, with the view of selecting the most probable value. The amount of discordance was in all cases very much the same as that shown in the plate for the series of experiments at two tons' pressure and the one temperature 5° C. It will be observed that the extreme limits of divergence from the mean are not more than about two units in the third significant place. For a pressure of one ton this corresponds to about half a millimetre in the position of the indices, so that after what has been said about their peculiarities of behaviour it may obviously be treated as unavoidable error. Thus the ordinary process of taking means is applicable, unless the observations themselves show some peculiarity which forbids the use of this method.

All the results of observations made up to June 1887 (with the help of the Amagat gauge) having been treated in this way, the following mean values of *apparent* average compressibility (multiplied by 10^8) were deduced from them :—

Apparent Compressibility of Cistern Water, boiled for a short time.

Temp. C.	1 ton.	2 tons.	3 tons.
0°·4	4770	4617	4510
3°·2	4670	4527	4402
3°·4	4671	4521	4395
11°·8	4415	4276	4163
14°·2	4330	4220	4115
14°·4	4344	4217	4105
15°·0	4338	4219	4102

[I think it extremely probable that the small irregularities among the last three numbers in each pressure column may be due to want of uniformity of temperature throughout the column of water in the pressure chamber. The day-temperature of the cellar is, in summer, always a good deal above that at night, so that in the forenoon (when the experiments were made) the gun and its contents were steadily growing warmer. Thus the column of water was not at a uniform temperature. The assumed temperature was the mean of the readings before the vessel containing the piezometers was inserted, and after it was taken out. While it was in the chamber, the contents could not be properly stirred except by raising and depressing the vessel itself.]

The points thus determined were laid down (marked with a $*$) as in Plate I., and smooth curves were drawn *liberâ manu* among them. From these curves the

following values were taken at intervals of 5° for the sake of ease of calculation, 260 being added to each for the compressibility of glass :—

	0°.	5°.	10°.	15°.
1 ton,	5044	4874	4723	4594
2 tons,	4898	4733	4584	4466
3 tons,	4776	4608	4468	4360

The fact that water has a temperature of minimum compressibility led me to try to represent these numbers by a separate parabolic formula for each pressure. The following were easily found :—

$$\left.\begin{array}{l} 504 - 3{\cdot}60t + 0{\cdot}04t^2, \\ 490 - 3{\cdot}65t + 0{\cdot}05t^2, \\ 478 - 3{\cdot}70t + 0{\cdot}06t^2, \end{array}\right\} \quad . \ . \ . \ (A)$$

for 1, 2, and 3 tons respectively. [The terms independent of t belong to the formula $520 - 17p + p^2$. This will be made use of in future sections.] The utmost difference between the results of these formulæ and the numbers from which they were obtained is less than 1/10th per cent. No closer approximation could be desired, much less expected, especially when we consider the way in which the * points (on which the whole depends) were themselves obtained. These are represented as follows :—

0°·4.		3°·2.		11°·8.		14°·4.		15°·0.	
Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
503	502·5	493	493	467·5	467·2	460·4	460·5	459·8	459
487·7	488·5	478·7	479	453·6	453·9	447·7	447·8	447·9	446·5
477	476·5	466·2	466·8	442·3	442·7	436·5	437·1	436·2	436

In one instance only does the difference reach unit in the third significant place. [It must be remembered that all these numbers commence with the fifth digit after the decimal point.]

In spite of some remarks above as to uncertainty about temperature, I am convinced that the mode of experimenting employed is calculated to insure considerably greater accuracy in the comparison of compressibilities at different temperatures for any one pressure, than in that of compressibilities for different pressures at any one temperature. The displacement of the indices by the expanding water is likely to be more serious the higher the pressure, as the difficulty of effecting the relief quietly is much greater. Probably all the values for the higher pressures are a little too small for this reason.

The results given above are represented with a fair degree of accuracy by the simple formula

$$\frac{0{\cdot}001863}{36+p}\left(1 - \frac{3t}{400} + \frac{t^2}{10{,}000}\right)$$

which will amply suffice for ordinary purposes. In this form, however, some small

but highly expressive and apparently important features of the formulæ (A) for the separate pressures are, of course, lost. The statement above, as to the greater uncertainty of the values the higher the pressure, renders it probable that, in the pressure factor in this formula, both the constants ought to be somewhat larger. It is clear that very small changes in the relative values of the compressions for 1, 2, and 3 tons would make great changes in these constants. In fact, an error of 1 per cent. at 3 tons involves an error of some twenty per cent., nearly, in each of the constants of the pressure factor.

Again, this last formula would give, *for all pressures*, minimum compressibility at about 37° C.; while the former three give 45° C. at 1 ton, 36°·5 at 2, and 30°·8 at 3 tons:—these minima being 423, 423·4, and 421 respectively.

If we venture to extend the formulæ (A) to atmospheric pressure, we are led to

$$520 - 3{\cdot}55t + 0{\cdot}03t^2$$

I have already shown[1] that this is in close accordance with Buchanan's results at 2°·5 and 12°·5 C. Buchanan's pressure unit is thoroughly trustworthy; for it was determined by letting down the piezometer, with a Challenger thermometer attached, to a measured depth in the ocean. It would thus appear that the extension of my formulæ to low pressures is justified by the result to which it leads.

This formula gives 415 for the minimum compressibility of water at low pressures, the corresponding temperature being about 60° C. This accords remarkably with the determination made by Pagliani and Vincentini, who discovered it, and placed it at 63° C.

On Plate II. I have exhibited graphically a number of known determinations of the compressibility of water for very low pressures at different temperatures. The line marked *Hypothetical* is drawn from the formula above, the authors of the others are named in the plate. It will be seen at a glance that, if Pagliani and Vincentini had taken Grassi's value of the compressibility of water at 1°·5 C., instead of that at 0° C., as their single assumption, their curve would have coincided *almost exactly* with my Hypothetical curve!

So far matters seemed to have gone smoothly enough. But when I came to reduce the observations made *since* June 1887, I found that they gave a result differing, slightly indeed but in a consistently characteristic manner, from that already given. The processes of reduction were carried out precisely as before; and the points determined by the second series of observations are inserted in Plate I., marked with a ⊙. Curves drawn through them as before are now seen to be *parallel* to the former curves, but not coincident with them. And the amount of deviation steadily diminishes from the lowest to the highest pressure. These curves, of course, are very closely repre-

[1] See p. 14, above.

sented by the formulæ (A) above, provided the first terms be made 499, 488, 477 respectively, *i.e.* provided 5, 2, and 1 be subtracted from the numbers for 1, 2, and 3 tons respectively. Thus, while the amount of the compressibility is reduced, it is made to depend on temperature precisely as before, but the way in which it depends on pressure is altered. The rate of diminution of compressibility with increase of pressure is now made constant at any one temperature, instead of becoming slowly less as the pressure is increased. This is incompatible with the results of all of the first series of experiments. The total amount of the compressibility is likewise diminished, by 1 per cent. at 1 ton, by 0·4 per cent. at 2 tons, and by 0·2 per cent. at 3 tons.

Small as these differences are, their regularity struck me as very remarkable, and as pointing definitely to some difference of conditions between the two sets of experiments. Now there were undoubtedly many circumstances in which the series of experiments differed :—

First. The observers were not the same. All the readings in the first series were made by myself; but (in consequence of an accident which prevented me from working in the cellar) I was unable to take part in the second series, and the readings for it were all made by Mr. Dickson. Thus there may be a difference, of personal equation, in the mode of applying the scale to the stem of the piezometer, or in the final adjustment of the manometer. Such an explanation is quite in accordance with the results, as a constant difference of reading would tell most when the whole quantity measured is least, *i.e.* at the lowest pressure. But a difference of a full millimetre in the piezometer readings may be dismissed as extremely improbable.

Second. It is possible that, during the second series of experiments, less care may have been taken than in the first series to let off the pressure with extreme slowness. Thus the indices may have been slightly washed down, and the record of compression rendered too small. Even with the greatest care, this undoubtedly occurred in some, at least, of the experiments of the first series; and the screw-tap may have been altered for the worse during the second series.

Third. It is recorded in the laboratory book that, during the second series of observations (which were made for the most part in the exceptionally cold weather of last spring) the oil and treacle in the manometer had become very viscous, so that it was difficult to make the pistons rotate. As artificial cooling, of the pressure apparatus alone, was employed in the first series, this objection does not apply to it. A constant zero error of 4 mm. only in the gauge would fully explain the discrepancy. And there was another cause which may have tended to produce this result, viz. the oxidation of the mercury in the manometric column, which had soiled the interior of the lower part of the tube, and thus made it very difficult to read the zero.

Fourth. The piezometers had been twice refilled, and of course slightly altered in content, between the two series, and the hair indices had necessarily been changed.

The former cause could have produced no measurable effect; but if the indices were *all* somewhat stiffer to move in the second series than in the first, the discrepance might be fully accounted for.

Fifth. Between the two series all the piezometers had, for several months, been filled with strong salt-solutions. Imperfect washing out of these solutions may have had the effect of rendering the second series a set of experiments on water very slightly salt.

Sixth. To make my observations applicable to natural phenomena, I purposely did not employ distilled water. The ordinary water supply of Edinburgh is of very fair quality, and I took care that it should not be boiled longer than was absolutely necessary to prevent air-bubbles from forming in the piezometers. But it comes from different sources, and is supplied as a mixture containing these in proportions which vary from time to time. From this cause also the substance operated upon may have been slightly different in the two series of experiments.

As will be seen in next section, I have obtained direct proof that the first series of observations is to be preferred to the second,—though I have not been able to ascertain definitely which of the above causes may have been most efficient in producing the discrepancy.

It will be observed that this discussion has nothing to do with the important question, Does the compressibility of water diminish from the very first as the pressure increases, as was asserted by Perkins? The first and rudest of my experiments sufficed to answer this definitely in the affirmative; though the contrary opinion has been confidently advanced, and is very generally held to this day.

The discussion deals with a much more refined and difficult question, viz. Is the diminution of average compressibility simply proportional to the pressure for the first few hundred atmospheres, or does the compressibility fall off more slowly than that proportion would indicate, as the pressure is raised?

VIII. Reductions, Results, and Formulæ for Sea-Water.

As already stated, three of the six piezometers employed were filled with fresh water and three with sea-water, so that simultaneous observations were made on the two substances. The accordance among the various observations made with sea-water, at any one temperature and pressure, was not so good as it was with fresh water; especially when the smaller compression apparatus was used. There is some curious action of salt upon the hairs attached to the indices, which has the effect of rendering them too loose, however stiffly they may originally have fitted the tube. Treating the observations of the first series exactly as described in the preceding section, I obtained

the points marked * in Plate I. Drawing smooth curves through these, I obtained parabolic formulæ for the apparent compressibility. These gave the following results when compared with the data from observation :—

APPARENT COMPRESSIBILITY OF SEA-WATER.

	1 ton.		2 tons.		3 tons.	
	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
0°·4	435	435	420	420	410	410
3°·0	427	427	413	413	402·5	403
11°·8	404	404	392	392	383·5	384
14°·2	398	399	389	388	380	380
15°·0	398	397	387	387	378	378

Adding the correction for glass, the formulæ became, for 1, 2, and 3 tons respectively—

$$\left.\begin{array}{l} 462 \quad - 3{\cdot}20t + 0{\cdot}04t^2, \\ 447{\cdot}5 - 3{\cdot}05t + 0{\cdot}05t^2, \\ 437{\cdot}5 - 2{\cdot}95t + 0{\cdot}05t^2, \end{array}\right\} \quad . \; . \; . \quad (\mathrm{B})$$

which may be compared with (A) for fresh water; and which may be approximately expressed in the form (very nearly correct for $p=2$)—

$$\frac{0{\cdot}00179}{38+p}\left(1 - \frac{t}{150} + \frac{t^2}{10{,}000}\right)$$

with sufficient accuracy for most purposes of calculation.

Of course it is easy to deduce from formulæ (B) the points of minimum compressibility, etc., for different pressures; but the data are scarcely accurate enough to warrant such a proceeding. We may, however, extend the formulæ tentatively to the case of very low pressures, for which we obtain

$$481 - 3{\cdot}4t + 0{\cdot}03t^2.$$

[The term independent of t in the formulæ (B) is of the form

$$481 - 21{\cdot}25p + 2{\cdot}25p^2.]$$

The second series of observations gave, when reduced, the points marked ⊙ on the plate. The curves which I have drawn, and which evidently suit them very closely, are *parallel* respectively to the curves drawn through the * points. The interval between them is throughout about 7 for 1 ton, 4 for 2 tons, and 3 for 3 tons, which must be subtracted from the first terms of (B) respectively. The corresponding intervals for the fresh water curves in the two series were 5, 2, 1. The differences of corresponding intervals between the sets of curves are 2, 2, 2; the same for all the groups of four curves each.

This seems to throw light on the question raised in last section, and to show that the main cause of the discrepancy between the first and second series of observations is not due to a difference in the substance operated on. The constant *difference* of the differences is due to such a cause, being at once traceable to the fact that the sea-water put into some of the piezometers for the second series of experiments was taken from the same Winchester quart bottle as was that with which they had been filled two years before. During these two years the sea-water had probably, by evaporation, become slightly stronger, and, therefore, less compressible. The change of compressibility is less than 0·5 per cent. of the whole, and is therefore practically (as it is in the third significant figure) the same for all three pressures. If we now look back to the suggested explanations in last section, we see that the above remarks entirely dispose of the fifth and sixth so far as fresh water is concerned, though the sixth, in a modified form, has to do in part with the discrepancy between the two series of observations on sea-water.

To decide between the two series I made a new set of observations, employing the two piezometers of large capacity spoken of at the end of Section III. These are called M_1 and M_2. On the first day of experimenting M_1 held sea-water from a Winchester quart filled at the same time with the first, but which had remained unopened. M_2 had fresh water. On the second day M_2 held sea-water, and M_1 fresh water. The object of this was to discover, if such existed, errors in the calibration of the piezometers, and then to eliminate them by a process akin to that of weighing with a false balance.

One of the ordinary piezometers (∵), filled with fresh water, was associated with the others as a check. I quote the results of one experiment only, made on the second day:—

5/6/88				[0·997 ton]
5	9°·4	M_1	310·9	[4465]
422		M_2	234·7	[4080]
5		∵	126·0	[4463]

Thus we have the following comparison of estimates of true average compressibility for the first additional ton:—

		Fresh Water.	Sea-Water.
9°·4	1st Series	474	434
	2nd „	469	427
	New „	473	434

A few of the experiments were not thoroughly decisive; none were in favour of the second series. This seems (so far as the first ton is concerned) to settle the question in favour of the first series.

The formulæ (A) and (B) may therefore, for 1 ton at least, be regarded as

the points marked * in Plate I. Drawing smooth curves through these, I obtained parabolic formulæ for the apparent compressibility. These gave the following results when compared with the data from observation :—

APPARENT COMPRESSIBILITY OF SEA-WATER.

	1 ton.		2 tons.		3 tons.	
	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
0°·4	435	435	420	420	410	410
3°·0	427	427	413	413	402·5	403
11°·8	404	404	392	392	383·5	384
14°·2	398	399	389	388	380	380
15°·0	398	397	387	387	378	378

Adding the correction for glass, the formulæ became, for 1, 2, and 3 tons respectively—

$$\left.\begin{array}{l} 462 \quad -3{\cdot}20t+0{\cdot}04t^2, \\ 447{\cdot}5-3{\cdot}05t+0{\cdot}05t^2, \\ 437{\cdot}5-2{\cdot}95t+0{\cdot}05t^2, \end{array}\right\} \quad . \; . \; . \quad (B)$$

which may be compared with (A) for fresh water; and which may be approximately expressed in the form (very nearly correct for $p=2$)—

$$\frac{0{\cdot}00179}{38+p}\left(1-\frac{t}{150}+\frac{t^2}{10,000}\right)$$

with sufficient accuracy for most purposes of calculation.

Of course it is easy to deduce from formulæ (B) the points of minimum compressibility, etc., for different pressures; but the data are scarcely accurate enough to warrant such a proceeding. We may, however, extend the formulæ tentatively to the case of very low pressures, for which we obtain

$$481-3{\cdot}4t+0{\cdot}03t^2.$$

[The term independent of t in the formulæ (B) is of the form

$$481-21{\cdot}25p+2{\cdot}25p^2.]$$

The second series of observations gave, when reduced, the points marked ⊙ on the plate. The curves which I have drawn, and which evidently suit them very closely, are *parallel* respectively to the curves drawn through the * points. The interval between them is throughout about 7 for 1 ton, 4 for 2 tons, and 3 for 3 tons, which must be subtracted from the first terms of (B) respectively. The corresponding intervals for the fresh water curves in the two series were 5, 2, 1. The differences of corresponding intervals between the sets of curves are 2, 2, 2; the same for all the groups of four curves each.

This seems to throw light on the question raised in last section, and to show that the main cause of the discrepancy between the first and second series of observations is not due to a difference in the substance operated on. The constant *difference* of the differences is due to such a cause, being at once traceable to the fact that the sea-water put into some of the piezometers for the second series of experiments was taken from the same Winchester quart bottle as was that with which they had been filled two years before. During these two years the sea-water had probably, by evaporation, become slightly stronger, and, therefore, less compressible. The change of compressibility is less than 0·5 per cent. of the whole, and is therefore practically (as it is in the third significant figure) the same for all three pressures. If we now look back to the suggested explanations in last section, we see that the above remarks entirely dispose of the fifth and sixth so far as fresh water is concerned, though the sixth, in a modified form, has to do in part with the discrepancy between the two series of observations on sea-water.

To decide between the two series I made a new set of observations, employing the two piezometers of large capacity spoken of at the end of Section III. These are called M_1 and M_2. On the first day of experimenting M_1 held sea-water from a Winchester quart filled at the same time with the first, but which had remained unopened. M_2 had fresh water. On the second day M_2 held sea-water, and M_1 fresh water. The object of this was to discover, if such existed, errors in the calibration of the piezometers, and then to eliminate them by a process akin to that of weighing with a false balance.

One of the ordinary piezometers (·.·), filled with fresh water, was associated with the others as a check. I quote the results of one experiment only, made on the second day:—

5/6/88					[0·997 ton]
	5	9°·4	M_1	310·9	[4465]
	422		M_2	234·7	[4080]
	5		·.·	126·0	[4463]

Thus we have the following comparison of estimates of true average compressibility for the first additional ton:—

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	New ,,	473	434

A few of the experiments were not thoroughly decisive; none were in favour of the second series. This seems (so far as the first ton is concerned) to settle the question in favour of the first series.

The formulæ (A) and (B) may therefore, for 1 ton at least, be regarded as

approximations to the truth, probably about as close as the apparatus and the method employed are capable of furnishing.

They show that the ratio of compressibilities of sea-water and fresh water varies but little from

$$0{\cdot}92$$

throughout a range of temperature from 0° to 15° C.

[The doubts as to the behaviour of the indices, which have been more than once alluded to above, have just led me to make a series of experiments (at one temperature but at different pressures) by the help of the silvering process. The results with fresh water were not much more concordant than when the hair-indices were used. When means were taken, exactly as before, it was found that the results for 1 ton were almost identical with the former. For 2 tons the average value was usually *greater* than before by a unit (and in some cases two units) in the third place. For 3 tons it was also greater, but now by one or two (and sometimes three) units. Hence it is probable that the hair-indices do behave as I suspected, but that the effect is small,—not at the worst (*i.e.* at the highest pressure) more than about 0·5 per cent. of the mean value found. With sea water there was a complex reaction, which made it difficult to read the indications of the silver film. The ratio of the true compressibilities of sea-water and fresh water was now found to be about 0·925, the value which I gave from my earliest experiments. 30/6/88.]

Dr. Gibson has furnished me with the following data regarding specimens of sea-water taken from two of the Winchester quarts filled off the Isle of May. One of these had remained unopened; the other had been often opened, and not closed with special care. These correspond (at least closely) to the materials used in the first and second series of experiments respectively :—

	Density.		
Percentage of Cl.	0° C.	6° C.	12° C.
1·8649	1·027286	1·026745	1·025834
1·9094	1·027941	1·027405	1·026462

Taking the reciprocals in the last three columns, we have

Volume.		
0° C.	6°	12°
0·973439	0·973951	0·974816
0·972818	0·973326	0·974220

Expressing these volumes as parabolic functions of the temperature, we find, for the maximum density points, $-5^{\circ}{\cdot}7$ and $-4^{\circ}{\cdot}9$ respectively.

IX. Compressibility, Expansibility, etc., of Solutions of Common Salt.

This part of the inquiry was a natural extension of the observations on sea-water, but it was also in part suggested by the fact that an admixture of salt with water produces effects very similar to those of pressure. Thus it appeared to me that an investigation of the compressibility of brines of various strengths might throw some light on the nature of solution; and also on the question of the internal pressure of liquids, which (in some theories of capillary forces) is regarded as a very large quantity.

The solutions experimented on contained, roughly, 4, 9, 13·4, and 17·6 per cent. of common salt. The piezometers used for the experiments already described were filled with these solutions in July 1887; one, for comparison, being left full of fresh water. I obtained a large number of results at temperatures about 1°, 9°, and 19° C., and at 1, 2, and 3 tons weight per square inch. Unfortunately these were still more discordant than those made with sea-water; so much so, in fact, that an error of 1 or occasionally even 2 per cent. was not by any means uncommon. However, by plotting all the observations exactly as described in the two last sections, I found that they could be *fairly* represented by the curves shown in Plate I. In most cases two at least of the three points for each curve were fairly determinate; one of these being, in all cases, within a degree or so of 10° C. For this was obtained by experiments in the large gun, where the difficulty of relieving the pressure without jerks is much less than in the smaller apparatus. Of the *general* accuracy of these curves I have no doubt. Thus, for instance, it is certain that the compressibility at any one temperature and pressure diminishes rapidly as the percentage of salt increases. And the rate at which the compressibility (for any one range of pressure) diminishes as temperature increases, becomes rapidly less as the solution is stronger. My observations do not enable me to settle the more delicate question of the variation of the rate at which the compressibility (at any one temperature) falls off with increase of pressure in the various solutions. For the limits of error in the various determinations, especially with the more nearly saturated solutions, are quite sufficient to mask an effect of this kind unless it were considerable. An attempt, however, will be made in next Section.

There is little to be gained by putting the results of the inquiry in a tabular form; for they can be obtained from the plate quite as accurately as is warranted by the limits of uncertainty of the experiments. See p. 47.

I am indebted to Dr. Gibson for the following determinations, which have a high

[In obtaining the first of these numbers, I assumed from Despretz that the density of water at 1 atm. and -9°C. is 0·9984.] Of course it would be vain to attempt similar calculations for the stronger solutions, as the indicated maximum density points are so widely outside the limits of my experiments. But the example just given seems to show that if fresh water be made, by pressure, to have its maximum density point the same as that of a common-salt solution under atmospheric pressure, the densities of the two will be nearly the same at that point, and will remain nearly alike as temperature changes.

NOTE.

In all that precedes it has been tacitly assumed :—

1. That the pressure is the same outside and inside the piezometer.
2. That the pressure measured by the gauge is that to which the contents of the piezometer were exposed.
3. That the pressure was uniform throughout the contents.

None of these is strictly true, so that cause must be shown for omitting any consequent correction.

The third may be dismissed at once, as the height of the piezometer bulb is only a few inches.

The difference of levels between the upper end of the gauge and the bulbs of the piezometers, when in the pressure-chamber, was about three feet, so that on this account the pressure applied was less than that in the gauge by one-tenth of an atmosphere. But as *differences* of pressure alone were taken from the gauge, this cause merely *shifts* (to a small extent) the range through which the compression was measured. But the rise of mercury in the piezometer stem made a reduction of the range of pressure as measured, which for 3 tons pressure might amount to about 0·5 atm. The error thus introduced was, at the utmost, of the order 0·1 of the compressibility measured. Thus the second cause, also, produces only negligible effects.

I preferred to settle the first question by experiment rather than by calculation, as the obtaining of the data for calculation would have required cutting up of the piezometer bulbs. The 0·5 atm. spoken of above represented, in extreme cases, the excess of external over internal pressure in the piezometers. By direct experiment on two of the instruments themselves, it was found that their internal volume was diminished at most 0·00002 of the whole by 0·6 atm. of external pressure. This would involve as a correction the adding of 0·1 per cent. only to the results at 3 tons, so that it also is well within the limits of error of the measurements above.

ASSOCIATED PHYSICAL QUESTIONS.

X. Theoretical Speculations.

If instead of the percentage of NaCl in the solutions we tabulate the amount of NaCl to 100 of water, and along with it the compressibility at zero, we have—

s = amount of NaCl to 100 of water.	Average compressibility at 0° C. × 10^7. For first ton.	First 2 tons.	First 3 tons.
0·0	503	490	477
4·0	449	438	428
9·6	396	386	378
15·4	354	345	338
21·4	321	313	306

The relation between these numbers is very fairly represented by the formula—

$$\text{Average compressibility for first } p \text{ tons} = \frac{0{\cdot}00186}{36+p+s}$$

It is remarkable that if we put $t=0$ in the formula of Section VII., we have—

$$\text{Average compressibility of fresh water for first } p+s \text{ tons} = \frac{0{\cdot}00186}{36+p+s}$$

which presents an exceedingly striking resemblance to that last written.

Though these formulæ are only approximate, we may assume the true constants to be at least nearly the same in both, and make the following statement as a sort of *memoria technica* in this subject :—

At 0° C. the average compressibility, for p tons, of a solution of s lbs. of common salt in 100 lbs. of water, is nearly equal to the average compressibility of fresh water for the first $p+s$ tons of additional pressure.

The numerical coincidence above is, of course, accidental; because the formulæ are taken for the special temperature 0° C., and the special unit of pressure 1 ton weight per square inch.

But a coincidence of a much more striking character, and one which does not depend upon special choice of units, is suggested by the common *form* of the expressions compared.

It appears from the Kinetic Theory of Gases, in which the particles are treated as hard spheres, whose coefficient of restitution is 1, and which exert no action on one another except at impact, that the pressure and volume of the group at any one temperature are connected by a relation approximately of the form

$$p\,(v-a) = \text{constant}.$$

The quantity a obviously denotes the ultimate volume, *i.e.* that to which the group would be reduced if the pressure were infinite.

I have pointed out[1] that this expression coincides almost exactly with the results of Amagat's experiments on the compression of hydrogen. The introduction of an attractive force between the particles, sensible only when they are at a mutual distance of the order of their diameters, merely alters the constants in this expression. Let us see what interpretation it will bear if, for a moment, we suppose it roughly to represent the state of things in water.

The average compressibility of such a group of particles, between the pressures ϖ and $\varpi+p$, viz.,

$$\frac{v_0 - v}{pv_0}$$

where v_0 is the volume at ϖ, and v that at $\varpi+p$, is easily shown to be

$$\frac{1-\dfrac{a}{v_0}}{\varpi+p}$$

Compare this with the empirical expression above for the compressibility of water say at 0° C. (per ton weight on the square inch)—

$$\frac{152\cdot3 \times 0\cdot00186}{36+p} = \frac{0\cdot283}{36+p}$$

and we see that they agree exactly in form. If, then, the results of the kinetic theory be even roughly applicable to the case of a liquid, we may look upon the 36 in this expression as the number of tons weight per square inch by which the internal pressure of water exceeds the external pressure. And the corresponding empirical expression for the compressibility of a solution of common salt may be interpreted as showing that the addition of salt to water increases the internal pressure by an amount simply proportional to the quantity of salt added.

That liquids have very great internal pressure has been conjectured from the results of Laplace's and other theories of capillarity, in which the results are derived statically from the hypothesis of molecular forces exerted intensely between contiguous portions of the liquid, but insensibly between portions at sensible distances apart. A very interesting partial verification of this proposition was given by Berthelot[2] in 1850. By

[1] *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 90, 1886.

[2] *Ann. de Chimie*, tom. xxx. p. 232.

an ingenious process he subjected water to external *tension*, and found that it could support at least fifty atmospheres. The calculation was made on the hypothesis that a moderate negative pressure increases the volume of water as much as an equal positive pressure diminishes it.

I was led to the conclusion that the internal pressure of a liquid must be greatly superior to the external, as a consequence of the remarkable results of Andrews' experiments on carbonic acid, and of the comments made on them by J. Thomson and Clerk-Maxwell.[1] It was Prof. E. Wiedemann who, while making an abstract of my paper (*Appendix* E) for the *Beiblätter zu den Ann. d. Physik*, first called my attention to Berthelot's experiment.

In *Appendix* F a short account of Laplace's calculations is given, and it is shown that the work required to carry unit volume of water, from the interior to a distance from the surface greater than the range of molecular forces, is

$$2\,K \times 1 \text{ cub. inch},$$

where K is the internal molecular pressure per square inch. The speculation above would make this work

$$72 \text{ inch-tons.}$$

But, in work units, the heat required to vaporize 1 cub. inch of water at 0°C. is

$$\frac{62\cdot5}{1728}606 \times 1390 \text{ foot pounds, or}$$
$$163 \text{ inch-tons.}$$

The two quantities are at least of the same order of magnitude, and it is to be remembered that what has been taken out in the one case is very small particles of *water;* in the other, particles of *vapour*. This raises another extremely difficult question, viz.,—What fraction of the whole latent heat is required to convert water, in excessively small drops, into vapour?

The comparison above, if it be well founded, would seem to show that the utmost reduction of volume which water at 0° C. can suffer by increase of pressure is 0·283; *i.e.* that water can be compressed to somewhat less than 3/4ths of its original bulk, but not further.

Of course the whole of this speculation is of the roughest character, for two reasons. The Kinetic gas formula has been proved only for cases in which the whole volume of the particles is small compared with the space they occupy. The compression formula is only an approximation, and was obtained for the range of pressures from 150 to 450 atmospheres; while we have extended its application to much higher pressures.

[1] *Theory of Heat*, chap. vi., London, 1871.

XI. Equilibrium of a Vertical Column of Water.

In Canton's second paper we have the following interesting statement :—

"The weight of $32\frac{1}{2}$ feet of sea-water is equal to the mean weight of the atmosphere: and, as far as trial has yet been made, every additional weight equal to that of the atmosphere, compresses a quantity of sea-water 40 millionth parts; now if this constantly holds, the sea, where it is two miles deep, is compressed by its own weight 69 feet 2 inches; and the water at the bottom is compressed 13 parts in 1000."

Either Canton overestimated the density of sea-water or he underestimated the amount of an atmosphere, for undoubtedly 33 feet is a much closer approximation to the column of sea-water which produces 1 atmosphere of pressure. He does not give his process of calculation, but it was probably something like this :—The pressure increases uniformly from the top to the bottom (neglecting the small effect due to change of density produced by compression), and everywhere produces a contraction proportional to its own value. Hence the whole contraction is equal to that which would have been produced if the pressure had had, at all depths, its mean value, *i.e.* that due to half the whole depth. This process, with Canton's numbers, gives nearly his numerical results.

If, then, a be the depth, and ρ_0 the original density, $g\rho_0 a/2$ is the mean pressure. If e be the compressibility, the whole contraction of a column, originally of length a, is $eg\rho_0 a^2/2$. Now, a mile of sea-water gives nearly 160 atmospheres of pressure, so that the loss of depth of a mile of sea (supposed at 10° C. throughout) is

$$160 \times 0{\cdot}000045 \times 5280/2 = 19 \text{ feet, nearly.}$$

For other depths it varies as the square of the depth; so that for two miles it is 76 feet, and for six miles 684 feet nearly.

This, however, is an overestimate, because we have not taken account of Perkins' discovery of the diminution of compressibility as the pressure increases. The investigation for this case is given in *Appendix* G, where the change of depth is shown to be

$$eg\rho_0 a^2/2\left(1 - \frac{2\varpi}{3\Pi} + \frac{\varpi^2}{2\Pi^2} - \ldots\right)$$

ϖ being the pressure at the bottom in tons weight per square inch, and Π (by Section VIII.) being 38 in the same units.

For six miles of sea this is, in feet—

$$684\left(1 - \frac{2}{19} + \frac{1}{80} - \text{\&c.}\right) = 620 \text{ nearly.}$$

In the *Appendix* referred to I have given a specimen of the hydrostatic problems to which this investigation leads. Any assigned temperature distribution, if not

essentially unstable, can be approximately treated. But the up- or down-rushes which result from instability are hopelessly beyond the powers of mathematics.

One remark of a curious character may be added, viz. that in a very tall column of water (salt or fresh), at the same temperature throughout, the equilibrium might be rendered unstable in consequence of the heat developed by a sudden large increase of pressure. For, as will be seen later, the expansibility of water is notably increased by pressure; and thus the lower parts of the column will become hotter, and less compressible, than the upper. This effect is not produced in a tall column of air, for the expansibility is practically unaltered by pressure. And the opposite effect is produced in bodies like alcohol, &c., where the compressibility steadily increases with rise of temperature.

XII. Change of Temperature produced by Compression.

The thermal effects of a sudden increase or relaxation of pressure formed an important element in my examination of the Challenger thermometers, and were practically the origin of this inquiry; one of the most unexpected of the results I obtained being the very considerable compression-change of temperature of the vulcanite slabs on which the thermometers are mounted. Thomson's formula for this heating effect, in terms of the pressure applied, and of the specific heat and expansibility of the body compressed, is given in *Appendix* C to my former Report. My first direct experiment on the subject was described as follows:[1]—

"When . . . the bulb of one of the thermometers was surrounded by a shell of lard upwards of half an inch thick, the total effect produced by a pressure of $3\frac{1}{2}$ tons weight was 5° F.; while for the same pressure, without the lard, the effect was only 1°·8 F. The temperature of the water in the compression apparatus was 43° F., so that the temperature effect due to the compression of water was less than 0°·2 F."

On May 16 of the same year I read a second note on the subject, from which I extract the following:[2]—

"I have examined for a number of substances the rise of temperature produced by a sudden application of great pressure, and the corresponding fall of temperature when the pressure was very suddenly relaxed. The copper-iron circuit is, however, too little sensitive for very accurate measurements; as, from the nature of the apparatus, the wires must be so thin as to have considerable resistance, and the thermo-electric power of the combination is not large. . . . I content myself, for the present, with a general statement of the results for cork and for vulcanized india-rubber, which are apparently typical of two classes of solids quite distinct from one another in their behaviour.

[1] *Proc. Roy. Soc. Edin.*, vol. xi. p. 51, 1881.

[2] *Proc. Roy. Soc. Edin.*, vol. xi. pp. 217, 218, 1881.

"In the case of india-rubber the rise of temperature was found to be about 1°·3 F for each ton-weight of pressure per square inch; and the fall in relaxation was almost exactly the same.

"With cork each additional ton of pressure gave less rise of temperature than the preceding ton; and the fall on relaxation of pressure was, for one or two tons, only about half the rise. For higher pressures its ratio to the rise became greater. Two tons gave a rise of about 1°·6 F., and a fall of 0°·9 F.

"With the same arrangement, the fall of temperature in water suddenly relieved from pressure at a temperature of 60° F. was found to be for

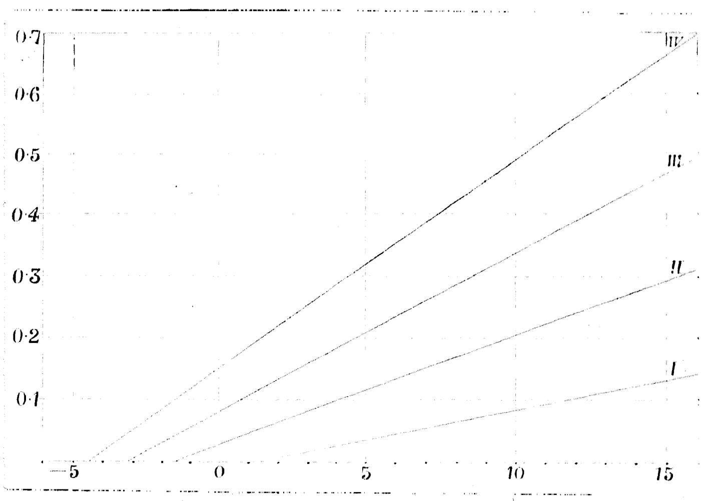
One ton-weight per square inch,			0°·25 F.
Two	,,	,,	0°·56 ,,
Three	,,	,,	0°·93 ,,
Four	,,	,,	1°·35 ,,

"These numbers give the averages of groups of fairly concordant results. I employed cooling exclusively in these experiments, because one of the valves of my pump was out of order, and the pressure could not be raised at a uniform rate. The effects obtained for successive tons of pressure are thus, roughly, 0°·25, 0°·31, 0°·37, and 0°·42 F.

"If these results may be trusted, they probably indicate a lowering of the maximum-density point of water by pressure."[1]

In the next extract it will be seen that I deduced from these data a lowering of the maximum-density point amounting to about 3° C. per ton.

The experiments on water were carried further in the following year by Professors



Marshall and Michie Smith, and Mr. Omond.[2] The second of their papers contains the annexed graphic representation of the results, which is alluded to in the following extract.

[1] [See footnote to p. 27.] [2] *Proc. Roy. Soc. Edin.*, vol. xi. pp. 626 and 809, 1882.

The final result of these experiments, as assigned by the authors, was a probable lowering of the maximum-density point of water by 5° C. for one ton pressure. To this paper I added the following note (*l.c.* p. 813):—

"If we assume the lowering of the temperature of maximum-density to be proportional to the pressure, which is the simplest and most natural hypothesis, we may write

$$t_0' = t_0 - Bp,$$

where p is in tons weight per square inch.

"Now Thomson's thermo-dynamic result is of the form

$$\delta t = A(t - t_0')\delta p.$$

"This becomes, with our assumption,

$$\delta t = A(t - t_0 + Bp)\delta p.$$

"As the left-hand member is always very small, no sensible error will result from integrating on the assumption that t is constant on the right (except when the quantity in brackets is very small, and then the error is of no consequence). Integrating, therefore, on the approximate hypothesis that A and B may be treated as constants, we have for the whole change of temperature produced by a finite pressure p—

$$\Delta t = A(t - t_0)p + \tfrac{1}{2}ABp^2.$$

"I have found that all the four lines in the diagram given [from Messrs. Marshall, Smith, and Omond, on last page, where y is the heating effect of p tons at temperature t] can be represented, with a fair approach to accuracy, by the formula

$$y = 0{\cdot}0095(t - 4)p + 0{\cdot}017p^2,$$

where p has the values 1, 2, 3, 4 respectively. Hence, comparing with the theoretical formula, we have the values

$$A = 0{\cdot}0095, \quad B = 3^\circ{\cdot}6 \text{ C}.$$

"B expresses the lowering of the maximum-density point for each ton weight of pressure per square inch.

"It seems, however, that all the observations give considerably too small a change of temperature; for the part due to the first power of the pressure is from 30 to 40 per cent. less than that assigned by Thomson's formula and his numerical data. One obvious cause of this is the small quantity of water in the compression apparatus, compared with the large mass of metal in contact with it. This would tend to diminish all the results, whether heating or cooling; and the more so the more deliberately the experiments were performed. Another cause is the heating (by compression) of the *external* mercury in the pressure gauge. Thus the pressures are always overestimated; the more so the more rapidly the experiments are conducted. A third cause, which may also have some effect, is the time required by the thermo-electric junction to assume the exact temperature of the surrounding liquid.

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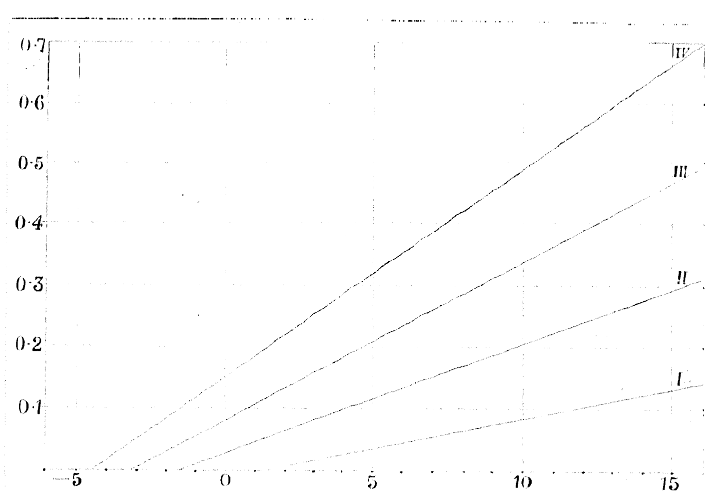

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"Be this, however, as it may, the following table shows the nature of the agreement between the results of my original experiments [*ante*, p. 52] and the data derived from the present investigations. The gauge and the compression apparatus were the same as in my experiments of last year; the galvanometer, the thermo-electric junctions, and the observers were all different. The column MSO gives the whole heating or cooling effect at 15°·5 C., calculated for different pressures from the results of the investigation by Professor Marshall and his coadjutors. The column T contains the results of my direct experiments at that temperature :—

p (tons)	MSO	T	Thomson.
1	0·131 C.	0·139 C.	0·177 C.
2	0·294	0·311	0·355
3	0·465	0·516	0·533
4	0·665	0·750	0·711

"It will be noticed that there is, again, a fair agreement; though the results are, as a rule, lower than those calculated from Thomson's formula. My own agree most nearly with Thomson's formula, probably because they were very rapidly conducted. As they stand, they give about 3° C. for the effect of 1 ton on the maximum-density point. It is to be observed that if we could get the requisite corrections for conduction and for compression of mercury, their introduction would increase (as in fact is necessary) the constant A above, but would have comparatively little effect on the value of B, which is the quantity really sought."

The experiments on other substances were carried out for me by Messrs. Creelman and Crocket, from whose important paper[1] I extract the following results, which have some connection with the subjects of this and of my former *Report* :—

Pressure.	Rise per ton.	Fall per ton.
	Cork, at 15° C.	
1	0°·75	0°·51
2	0°·65	0°·45
3	0°·59	0°·42
	Glass, at 15° C.	
1	0°·12	0°·12
2	0°·13	0°·14
3	0°·13	0°·14
	Gutta Percha, at 16° C.	
1	0°·65	0°·67
2	0°·60	0°·64
3	0°·58	0°·63
	Solid Paraffin, at 14° C.	
1	0°·56	0°·57
2	0°·56	0°·59
3	0°·54	0°·61
	Chloroform, at 17° C.	
1	1°·44	1°·45
2	1°·34	1°·45
3	1°·31	1°·47

Pressure.	Rise per ton.	Fall per ton.
	"Challenger" Vulcanite, at 16° C.	
1	0°·33	0°·33
2	0°·31	0°·33
3	0°·28	0°·32
	Indiarubber, at 15° C.	
1	0°·74	0°·79
2	0°·70	0°·79
3	0°·70	0°·80
	Beeswax, at 15° C.	
1	0°·83	0°·83
2	0°·79	0°·86
3	0°·78	0°·89
	Marine Glue, at 15°·5 C.	
1	0°·91	0°·98
2	0°·85	0°·90
3	0°·82	0°·91
	Sulphuric Ether, at 21° C.	
1	1°·8	1°·9
2	1°·74	1°·8
3	1°·7	1°·7

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. p. 311, 1885.

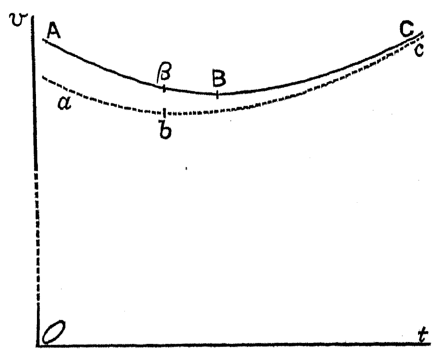
As was to be expected from the fact that the getting up of pressure requires a short time, while the relief is practically instantaneous, the heating effect is generally a little smaller than the cooling effect for the same change of pressure.

These experimenters thus completely confirmed my statements as to the curiously exceptional behaviour of cork, but they found no other substance, in the long list of those which they examined, which behaves in a similar manner.

It is to be remarked that as, in all the experiments described or cited in this section, the temperature-changes were measured by a thermo-electric junction which was itself exposed to the high pressures employed, there may be error due to the compression of the materials forming the junction. The wires were, for several reasons, very thin; so that the error, if any, is not due to changes of temperature in them, but to (possible) change of relative thermo-electric position, due to pressure. This is a very insidious source of error, and it is not easy to see how to avoid it.

XIII. Effect of Pressure on the Maximum-Density Point.

Though the lowering of the maximum-density point of water by pressure is an immediate consequence of Canton's discovery, that the compressibility diminishes as the temperature is raised, it seems to have been first pointed out, so lately as 1875, by Puschl.[1] I was quite unaware of his work, and of that of Van der Waals,[2] when (as shown in Section XII. above) I was led to the same conclusion by the differences between theory and experiment, as to the heat developed by compression of water.



This can very easily be shown as follows. Let the (vertical) ordinates of the curve ABC represent the volume of water at 1 atm., the abscissæ the corresponding temperatures, B the maximum-density point. Let the dotted curve *abc* represent the same for a greater pressure, say two atmospheres. Then, by Canton's result, the vertical distance between these curves (the difference between corresponding ordinates) diminishes continuously from A to C; so long, at least, as the temperature at C is under that of minimum compressibility. Hence the inclination of *abc* to the axis of temperatures is everywhere greater than that of the corresponding part of ABC. Thus the minimum, b, of the dotted curve (where its tangent is horizontal) must correspond to a point, β, in the full curve, where the inclination is *negative*—*i.e.* a point at a lower temperature than B.

[1] *Sitzungsb. d. math.-naturw. Cl. d. k. Akad. d. Wiss. Wien*, Bd. lxxii. p. 283, 1875.
[2] *Archives Néerl.*, tom. xii. p. 457, Haarlem, 1877.

To calculate the amount of this lowering, by the process indicated, we must know the form of the curve *abc*. This, in its turn, can be calculated from a knowledge of the form of ABC, and of the relation between compressibility and temperature. Both of the authors named took their data as to the latter matter from the experiments of Grassi; and, as was therefore to be expected, gave results wide of the truth. Puschl calculates a lowering of 1° C. by 87·6 atm., which is certainly too small; Van der Waals, 0°·78 C. by 10·5 atm., as certainly much too large.

To obtain a good estimate in this way is by no means easy, for authorities are not quite agreed as to the form of the curve ABC. If we calculate from the datum of Despretz, which has been verified by Rossetti,[1] namely,—

$$\frac{\text{vol. at } 0^\circ \text{ C.}}{\text{vol. at } 4^\circ \text{ C.}} = 1{\cdot}000136,$$

we obtain for the volume of water at 1 atm., in terms of temperature,

$$1 + 0{\cdot}0000085(t-4)^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

[This refers only to the part A B of the curve, which is what we want. There seems general agreement that the curve is not symmetrical about the ordinate at B.] Now, by (A), the factor for reduction of volume by 1 ton of additional pressure is

$$1 - 0{\cdot}007676 + 0{\cdot}000055t - 0{\cdot}00000061t^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The product of these factors, (1) and (2), is a minimum when

$$0{\cdot}000017(t-4) = -0{\cdot}000055 + 0{\cdot}00000122t;$$

or,

$$t = 4 - \frac{501}{158} = 4 - 3{\cdot}17.$$

Thus, according to these data, the maximum-density point is lowered by 3°·17 C. per ton of pressure. It will be observed that this is not much less than the result I calculated from the data of Professor Marshall and his comrades, but it agrees almost exactly with that which I derived from my own.

The following description of the results of my earlier attempts to solve this question *directly*, is taken from the Proc. Roy. Soc. Edin., vol. xii. pp. 226-228, 1883:—

"I determined to try a direct process analogous to that of Hope, for the purpose of ascertaining the maximum-density point at different pressures. The experiments presented great difficulties, because (for Hope's method) the vessel containing the water must have a considerable cross section; and thus I could not use my smaller compression apparatus, which was constructed expressly to admit of measurements of temperature by thermo-electric processes. I had therefore to work with the huge Fraser gun employed for the Challenger work, and to use the protected thermometers (which are very sluggish) for the measurement of temperatures. It was also necessary to work

[1] *Pogg. Ann.*, *Ergänzungsband*, v. p. 260, 1871.

with the gun at the temperature of the air,—it would be almost impossible to keep it steadily at a much lower temperature,—so that I had to work in water at about 12° C.

"The process employed was very simple. A tall cylindrical jar full of water had two Challenger thermometers (stripped of their vulcanite mounting) at the bottom, and was more than half-filled with fragments of table-ice floating on the water, and confined by wire-gauze at the top. This was lowered into the water of the gun, and pressure was applied.

"It is evident that *if there were no conduction of heat* through the walls of the cylinder, and if the ice lasted long enough under the steadily maintained pressure, the thermometers would ultimately show, by their recording minimum indices, the maximum-density point corresponding to the pressure employed:—always provided that that temperature is not lower than the melting point of ice at the given pressure.

"Unfortunately, all the more suitable bad conductors of heat are either bodies like wood (which is crushed out of shape at once under the pressures employed) or like tallow, &c. (which become notably raised in temperature by compression). I was therefore obliged to use glass. The experiments were made on successive days, three each day, with three different cylindrical jars. These had all the same height and the same internal diameter. The first was of tinned iron; the second of glass about $\frac{1}{6}$ inch thick; the third, of glass nearly an inch thick, was procured specially for this work.

"With the external temperature 12°·2 C., the following were the results of $1\frac{1}{2}$ tons pressure per square inch, continued in each case for 20 minutes (some unmelted ice remaining on each occasion). The indications are those of two different Challenger thermometers, corrected for index-error by direct comparison with a Kew standard:—

Tin Cylinder.	Thin Glass.	Thick Glass.
4° C.	2°·67	0°·83
4°	2°·61	0°·83

The coincidence of the first numbers with the ordinary maximum-density point of water is, of course, mere chance. When no pressure was applied, but everything else was the same, the result was—

Tin.	Thin.	Thick.
5°·7 C.	5°	4°

It is clear that the former set of numbers points to a temperature of maximum density, somewhere about 0° C., under $1\frac{1}{2}$ tons pressure per square inch. But still the mode of working is very imperfect.

"I then thought of trying a *double* cylindrical jar, the thin one above mentioned being enclosed in a larger one which surrounded it all round, and below, at the distance of about $\frac{3}{4}$ inch. Both vessels were filled with water, with broken ice floating on it,

and had Challenger thermometers at the bottom. By this arrangement I hoped to get over the difficulty due to the temperature of the gun, by having the inner vessel enclosed in water which would be lowered in temperature to about 3° C. by the application of pressure. The device proved quite successful. The result of $1\frac{1}{2}$ tons pressure per square inch maintained for 20 minutes, some ice being still left in each vessel, was from a number of closely concordant trials—

Temperature in outer vessel, . . .	1°·7 C.
Temperature in inner vessel, . . .	0°·3 C.

The direct pressure correction for the thermometers is only about −0°·1 C., and has therefore been neglected.

"The close agreement of this result with that obtained (under similar pressure conditions) in the thick glass vessel leaves no doubt that the lowering of the maximum-density point is somewhat under 4° C. for $1\frac{1}{2}$ tons, or 2°·7 C. for 1 ton per square inch. It is curious how closely this agrees with the result of my indirect experiments."

Further work of the same kind led me to the conclusion that even the double vessel had not sufficiently protected the contents from conducted heat, and to state in my Heat (p. 95, 1884) that "a pressure of 50 atmospheres lowers the maximum-density point by 1° C."

During the next two years I made several repetitions of these experiments, with the help of thermometers protected on the Challenger plan, but very much more sensitive. These experiments were not so satisfactory as those just described. The new thermometers caused a great deal of trouble by the uncertainty of their indications, which I finally traced to the fact that the paraffin oil which they contained passed, in small quantities, from one end of the mercury column to the other. I was occupied with an attempt to obtain more suitable instruments, when the arrival of the Amagat gauge turned my attention to other matters.

So far as I can judge from the results of the three different methods which I have employed, the lowering of the maximum-density point of water by 1 ton of pressure is very nearly, though perhaps a little in excess of, 3° C.

It is peculiarly interesting to find that Amagat, by yet another process,—viz. finding two temperatures not far apart at which water, at a given pressure, has the same volume,—has lately obtained a closely coinciding result. He says: "À 200 atm. (chiffres ronds) le maximum de densité de l'eau a rétrogradé vers zéro et l'à presque atteint; il parait situé entre zéro et 0°·5 (un demi-degré)."[1] This makes the effect of 1 ton slightly *less* than 3° C.

As the freezing point is lowered, according to J. Thomson's discovery, by about

[1] *Comptes Rendus*, tom. civ. p. 1160, 1887.

$1^{\circ}{\cdot}13$ only per ton of additional pressure,—and has a start of but 4°,—the maximum-density point will overtake it at about $-2^{\circ}{\cdot}4$, under a pressure of 2·14 tons.

The diagram 2 of Plate II. shows the consequences of the pressure-shifting of the maximum-density point in a very clear manner,—especially in its bearing on the expansibility of water at any one temperature but at different pressures. The curves in the diagram are for atmospheric pressure, and for additional pressures of 1, 2 and 3 tons respectively. They are traced roughly by the help of Despretz's tables of expansibility at atmospheric pressure, and the compression data of the present Report. The quantity of water taken in each case is that which, at 0° and under the particular pressure, has unit volume. Thus all the curves pass through the same point on the axis of volumes. How, in consequence of the gradual lowering of the maximum-density point, the expansibility at zero, which is negative at atmospheric pressure, and even at 1 ton of additional pressure, becomes positive and then rapidly greater as the pressure is raised, is seen at a glance.

I have to state, in conclusion, that my chief coadjutors in the experimental work have been Mr. H. N. Dickson and my mechanical assistant Mr. T. Lindsay. Mr. Dickson also reduced all the observations, about half of them having been done in duplicate by myself.

In the compression of glass I had the assistance of Mr. A. Nagel, and occasionally of Dr. Peddie.

Mr. A. C. Mitchell assisted me in the graphic work, and checked the calculations in the text.

I have already acknowledged the density determinations and analyses of sea-water and salt solutions made by Dr. Gibson.

And I have again been greatly indebted to the very skilful glass-working of Mr. Kemp.

[7/9/88.—The following analysis of the glass of my piezometers is given by Mr. T. F. Barbour, working in Dr. Crum Brown's Laboratory :—

SiO_2	=	61·20
PbO	=	20·94
$Al_2O_3 + Fe_2O_3$	=	0·82
CaO	=	2·20
MgO	=	0·26
K_2O	=	1·93
Na_2O	=	11·72.]

ADDENDUM (8/8/88).

THE reader has already seen that I have, more than once in the course of the inquiry, found myself reproducing the results of others. A few days ago I showed the proof-sheets of this Report to Dr. H. du Bois, who happened to visit my laboratory, and was informed by him that one of Van der Waals' papers (he did not know which, but thought it was a recent one) contains an elaborate study of the molecular pressure in fluids. I had been under the impression, strongly forced on me by the reception which my speculations (Appendix E., below) met with both at home and abroad, that Laplace's views had gone entirely out of fashion;—having made, perhaps, their final appearance in Miller's *Hydrostatics*, where I first became acquainted with them about 1850. In Van der Waals' memoir "On the Continuity of the Gaseous and Liquid States," which I have just rapidly perused in a German translation, the author expresses himself somewhat to the following effect: If I here give values of K for some bodies, I do it not from the conviction that they are satisfactory, but because I think it important to make a commencement in a matter where our ignorance is so complete that not even a single opinion, based on probable grounds, has yet been expressed about it.

Van der Waals gives, as the value of K in water, 10,500 atmospheres; and, in a subsequent paper, 10,700 atm.; while the value given in the text above is about half, viz. 5480 atm. So far as I can see, he does not state how these values were obtained, though he gives the data and the calculations for other liquids. It is to be presumed, however, that his result for water was obtained, like those for ether and alcohol, from Cagniard de la Tour's data as to any two of the critical temperature, volume, and pressure. Van der Waals forms, by a very ingenious process, a general equation of the isothermals of a fluid, in which there are but two disposable constants. This is a cubic in v, whose three roots are real and equal at the critical point. Thus the critical temperature, volume, and pressure can all be expressed in terms of the two constants, so that one relation exists among them. Two being given, the equation of the isothermals can be formed, and from it K can be at once found.

My process, as explained above, was very different. I formed the equation of the isothermal of water at 0° C. from the empirical formula for the average compressibility under large additional pressures; and by comparing this, and the corresponding equation for various salt solutions, with an elementary formula of the Kinetic theory of gases, I was led to interpret, as the internal pressure, a numerical quantity which appears in the equations.

I have left the passages, in the text and Appendix alike, which refer to this subject in the form in which they stood before I became acquainted with Van der Waals' work. I have not sufficiently studied his memoir to be able as yet to form a definite opinion whether the difficulty (connected with the non-hydrostatic nature of the pressure in surface films) which is raised in Appendix E. can, or cannot, be satisfactorily met by Van der Waals' methods. Anyhow, the isothermals spoken of in that Appendix are totally different from those given by Van der Waals' equation, inasmuch as the whole pressure, and not merely the external pressure, is introduced graphically in my proposed construction.

SUMMARY OF RESULTS.

It is explained in the preceding pages that the pressures employed in the experiments ranged from 150 to 450 atm., so that results given below for higher or lower pressures [and enclosed in square brackets] are extrapolated. A similar remark applies to temperature, the range experimentally treated for water and for sea-water being only 0° to 15° C. Also it has been stated that the recording indices are liable to be washed down the tube, to a small extent, during the relief of pressure, so that the results given are probably a little too *small*.

Compressibility of Mercury, per atmosphere, . . .	0·0000036
,, ,, Glass, ...	0·0000026

Average compressibility of fresh water:—

[At low pressures	520.10^{-7}	$-355.10^{-9}t$	$+3.10^{-9}t^2$]
For 1 ton = 152·3 atm.	504	360	4
2 ,, = 304·6 ,,	490	365	5
3 ,, = 456·9 ,,	478	370	6

The term independent of t (the compressibility at 0° C.) is of the form

$$10^{-7}(520-17p+p^2),$$

where the unit of p is 152·3 atm. (one ton-weight per sq. in.). This must not be extended in application much beyond $p=3$, for there is no warrant, experimental or other, for the minimum which it would give at $p=8·5$.

The point of minimum compressibility of fresh water is probably about 60° C. at atmospheric pressure, but is lowered by increase of pressure.

As an *approximation* through the whole range of the experiments we have the formula:—

$$\frac{0·00186}{36+p}\left(1-\frac{3t}{400}+\frac{t^2}{10,000}\right);$$

while the following formula exactly represents the average of all the experimental results at each temperature and pressure:—

$$10^{-7}(520-17p+p^2)-10^{-9}(355+5p)t+10^{-9}(3+p)t^2.$$

Average compressibility of sea-water (about 0·92 of that of fresh water):—

[At low pressures	481.10^{-7}	$-340.10^{-9}t$	$+3.10^{-9}t^2$]
For 1 ton	462	320	4
2 ,,	447·5	305	5
3 ,,	437·5	295	5

Term independent of t:—

$$10^{-7}(481 - 21{\cdot}25p + 2{\cdot}25p^2)$$

Approximate formula:—

$$\frac{0{\cdot}00179}{38+p}\left(1 - \frac{t}{150} + \frac{t^2}{10{,}000}\right)$$

Minimum compressibility point, probably about 56° C. at atmospheric pressure, is lowered by increase of pressure.

Average compressibility of solutions of NaCl for the first p tons of additional pressure, at 0° C.:—

$$\frac{0{\cdot}00186}{36+p+s}$$

where s of NaCl is dissolved in 100 of water.

Note the remarkable resemblance between this and the formula for the average compressibility of fresh water at 0° C. and $p+s$ tons of additional pressure.

[Various parts of the investigation seem to favour Laplace's view that there is a large molecular pressure in liquids. In the text it has been suggested, in accordance with a formula of the Kinetic Theory of Gases, that in water this may amount to about 36 tons-weight on the square inch. In a similar way it would appear that the molecular pressure in salt solutions is greater than that in water by an amount directly proportional to the quantity of salt added.]

Six miles of sea, at 10° C. throughout, are reduced in depth 620 feet by compression. At 0° C. the amount would be about 663 feet, or a furlong. (This quantity varies nearly as the square of the depth.) Hence the pressure at a depth of 6 miles is nearly 1000 atmospheres.

The maximum-density point of water is lowered about 3° C. by 150 atm. of additional pressure.

From the heat developed by compression of water I obtained a lowering of 3° C. per ton-weight per square inch.

From the ratio of the volumes of water (under atmospheric pressure) at 0° C. and 4° C., given by Despretz, combined with my results as to the compressibility, I found 3°·17 C.:—and by direct experiment (a modified form of that of Hope) 2°·7 C. The circumstances of this experiment make it certain that the last result is too small.

Thus, at ordinary temperatures, the expansibility of water is increased by the application of pressure.

In consequence, the heat developed by sudden compression of water at temperatures above 4° C. increases in a higher ratio than the pressure applied; and water under 4° C. may be heated by the sudden application of sufficient pressure.

The maximum density coincides with the freezing-point at −2°·4 C., under a pressure of 2·14 tons.

APPENDIX A.

ON AN IMPROVED METHOD OF MEASURING COMPRESSIBILITY.

"WHEN the compressibility of a liquid or gas is measured at very high pressures, the compression vessel has to be enclosed in a strong cylinder of metal, and thus it must be made, in some way, self-registering. I first used indices, prevented from slipping by means of hairs. Sir W. Thomson's devices for sounding, at small depths, by the compression of air, in which he used various physical and chemical processes for recording purposes, led me to devise and employ a thin silver film which was washed off by a column of mercury. Much of my work connected with the Challenger Thermometers was done by the help of this process. Till quite recently I was unaware that it had been devised and employed by Cailletet in 1873, only that his films were of gold.

"But the use of all these methods is very laborious, for the whole apparatus has to be opened *for each individual reading*. Hence it struck me that, instead of measuring the compression produced by a given pressure, we should try to measure the pressure required to produce a given compression. I saw that this could be at once effected by the simplest electric methods; *provided that glass, into which a fine platinum wire is fused, were capable of resisting very high pressures without cracking or leaking at the junctions.* This, on trial, was found to be the case.

"We have, therefore, only to fuse a number of platinum wires, at intervals, into the compression tube, and very carefully calibrate it with a column of mercury which is brought into contact with each of the wires successively. Then if thin wires, each resisting say about an ohm, be interposed between the pairs of successive platinum wires, we have a series whose resistance is diminished by one ohm each time the mercury, forced in by the pump, comes in contact with another of the wires. Connect the mercury with one pole of a cell, the highest of the platinum wires with the other, leading the wires out between two stout leather washers; interpose a galvanometer in the circuit, and the arrangement is complete. The observer himself works the pump, keeping an eye on the pressure gauge, and on the spot of light reflected by the mirror of the galvanometer. The moment he sees a change of deflection he reads

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 2, 3, 1884.

the gauge. It is convenient that the external apparatus should be made to leak slightly; for thus a *series* of measures may be made, in a minute or two, for the contact with each of the platinum wires. Then we pass to the next in succession."

M. Amagat[1] remarks on the use of this method as follows:—"Le liquide du piézomètre, et le liquide transmettant la pression dans lequel il est plongé (glycérine), s'échauffent considérablement par la pression; cette circonstance rend les expériences très longues: il faut un temps considérable pour équilibrer la masse qui est peu conductrice; il faut répéter les lectures jusqu'à ce que l'indication du manomètre devienne constante au moment du contact. Les séries faites par pressions décroissantes produisent le même effet en sens inverse; on prend la moyenne des résultats, dont la concordance montre que l'ensemble de la méthode ne laisse réellement presque rien à désirer.

"On voit par là quelles grossières erreurs ont pu être commises avec les autres artifices employés jusqu'ici pour la mesure des volumes dans des conditions analogues."

It must be remembered that M. Amagat is speaking of experiments in which pressures rising to 3000 atmospheres were employed.

[1] *Comptes Rendus*, tom. ciii. p. 431, 1886.

APPENDIX B.

RELATION BETWEEN TRUE AND AVERAGE COMPRESSIBILITY.

The average compressibility per ton for the first p tons of additional pressure is

$$\frac{v_0 - v}{pv_0};$$

where v_0 is the initial volume, and v is the volume at p additional tons.

The true compressibility at p additional tons is

$$-\frac{dv}{vdp}.$$

Hence, if one of these quantities is given as a function of p, it may be desirable to find the corresponding expression for the other. The simplest example, that on p. 30, will suffice to show the principle of the calculation. Let

$$\frac{v_0 - v}{pv_0} = e\,(1 - fp)\,; \quad . \; . \; . \; . \; (1)$$

where e is, in general, a much smaller quantity than f. We have

$$\frac{v}{v_0} = 1 - ep + efp^2,$$

whence

$$-\frac{dv}{vdp} = \frac{e\,(1 - 2fp)}{1 - ep + efp^2} = e\,(1 - (2f - e)\,p + \;.\;.\;.) \;.\;.\;.\;.\; (2)$$

where the expansion may be easily carried further if required.

If the terms in the second and higher powers of p are to be neglected, (1) and (2) as written show at once how to convert from true to average compressibility, or *vice versâ*.

APPENDIX C.

CALCULATION OF LOG. FACTORS.

LET W be the weight of mercury which would take the place of the liquid in the piezometer, w that of the mercury which fills a length l of the stem. Then a compression read as x on the stem is

$$\frac{x}{l}\frac{w}{\mathrm{W}}$$

This assumes the stem to be uniform; in general it must be corrected from the results of the calibration :—unless, as in the example given on p. 16 of the text, l be chosen very nearly equal to x, as found by trial for each value of the pressure.

Also if y be the reading of the gauge, and if a on the gauge correspond to an atmosphere, the pressure is

$$\frac{y}{a}\text{ atm.}$$

Hence the average apparent compressibility per atmosphere is

$$\frac{x}{y}\cdot\frac{wa}{l\mathrm{W}}$$

Its logarithm is

$$\log.\, x - \log.\, y + (\log.\, w - \log.\, \mathrm{W} - \log.\, l) + \log.\, a.$$

The last four terms, of which log. a is the "gauge log.," form the log. factor as given in the text

APPENDIX D.

NOTE ON THE CORRECTION FOR THE COMPRESSIBILITY OF THE PIEZOMETER.

The usual correction neglects the fact that when the compressibility of the liquid is different from that of the walls, the liquid under pressure does not occupy the *same part* of the vessel as before pressure.

Let V be the volume of the part of the vessel occupied by liquid; a that of the tube between the two positions of the index, both measured at 1 atmosphere; e, ϵ, the average absolute compressibility of liquid and vessel per ton for the first p additional tons. Equate to one another the volume of the liquid, and the volume of the part of the vessel into which it is forced, both at additional pressure p. We have thus—

$$V(1-ep) = (V-a)(1-\epsilon p)$$

whence

$$e = \epsilon\left(1 - \frac{a}{V}\right) + \frac{a}{pV}$$

As $\frac{a}{V}$ is usually small, this equation is treated as equivalent to

$$e = \epsilon + \frac{a}{pV}$$

i.e., the absolute compressibility of the liquid is equal to its apparent compressibility, added to the absolute compressibility of the envelop.

One curious consequence of the exact equation is that, if the compressibilities were both constant, or were known to change in a given ratio by pressure, it would be possible (theoretically at least) to measure absolute compressibilities by piezometer experiments alone, without employing a substance whose absolute compressibility is determined by an independent process. For the additional term in the exact equation makes the cöefficients of e and ϵ numerically different; whereas in the approximate equation they are equal, but with opposite signs, and therefore can give $e - \epsilon$ only.

In my experiments described above, a/V rarely exceeds 0·02, so that this correction amounts to (0·02 × 26 in 500, or) 5 units in the fourth significant place; and thus *just* escapes having to be taken account of. When 4 places are sought at lower pressures than 3 tons, or 3 places at pressures of 4 tons and upwards, it must be taken account of.

APPENDIX E.

ON THE RELATIONS BETWEEN LIQUID AND VAPOUR.

In connection with the present research a number of side issues have presented themselves, some of which come fairly within the scope of the Report. I commence by reprinting two Notes, read on January 19 and February 2, 1885, to the Royal Society of Edinburgh :[1]—

ON THE NECESSITY FOR A CONDENSATION-NUCLEUS.

"The magnificent researches of Andrews on the isothermals of carbonic acid formed, as it were, a nucleus in a supersaturated solution, round which an immediate crystallization started, and has since been rapidly increasing.

"They gave the clue to the explanation of the paradoxical result of Regnault, that hydrogen is less compressible and other gases more compressible, under moderate pressure, than Boyle's Law indicates; and to that of the companion result of Natterer that, at very high pressures, all gases are less compressible than that law requires. Thus they furnished the materials for an immense step in connection with the behaviour of fluids *above* their critical points.

"But they threw at least an equal amount of light on the liquid-vapour question, *i.e.* the behaviour of fluids at temperatures *under* their critical points. In Andrews' experiments there was a commencement, and a completion, of liquefaction; each at a common definite pressure, but of course at very different volumes, for each particular temperature.

"In 1871 Professor J. Thomson communicated to the Royal Society a remarkable paper on the *abrupt* change from vapour to liquid, or the opposite, indicated by these experiments. He called special attention to the necessity for a 'start,' as it were, in order that these changes might be effected. [It is to this point that the present Note is mainly directed, but I go on with a brief analysis of Thomson's work.] He pointed out that there were numerous experiments proving that water could be heated, under certain conditions, far above its boiling point without evaporating; and that, probably,

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 78 and 91, 1885.

steam might be condensed isothermally to supersaturation without condensing. Hence he was led to suggest an isothermal of continued curvature, instead of the broken line given by Andrews, as representing the *continuous* passage of a fluid from the state of vapour to that of liquid; the whole mass being supposed to be, at each stage of the process, in the same molecular state.

"In Clerk-Maxwell's 'Treatise on Heat,' this idea of J. Thomson's was developed, in connection with a remarkable speculation of W. Thomson,[1] on the pressure of vapour as depending on the curvature of the liquid surface in contact with it. This completely accounts for the deposition of vapour when a proper nucleus is present. Maxwell showed that it could also account for the 'singing' of a kettle, and for the growth of the larger drops in a cloud at the expense of the smaller ones.

"The main objection to J. Thomson's suggested isothermal curve of transition is that, as Maxwell points out, it contains a region in which pressure and volume increase or diminish simultaneously. This necessarily involves instability, inasmuch as, for definite values of pressure at constant temperature within a certain range in which vapour and liquid can be in equilibrium, Thomson's hypothesis leads to three different values of volume: two of which are stable; but the intermediate one essentially unstable. According to Maxwell, the extremities of this triple region correspond to pressures, at which, regarded from the view of steady increase or diminution of pressures, either the vapour condenses suddenly into liquid, or the liquid suddenly bursts into vapour.

"If this were the case, no nucleus would be *absolutely* requisite for the formation either of liquid from vapour or of vapour from liquid. All that would be required, in either case, would be the proper increase or diminution of pressure;—temperature being kept unaltered. The latent heat of vapour, which we know to become less as the critical point is gradually arrived at, would thus be given off in the explosive passage from vapour to liquid. It is difficult to see, on this theory, how it can be explosively taken in on the sudden passage from liquid to vapour.

"Aitken's experiments tend to show, what J. Thomson only speculatively announced, that possibly vapour may not be condensed (in the absence of a nucleus), when compressed isothermally, even at ranges far beyond the *maximum* of pressure indicated in Thomson's figures. Hence it would appear that the range of instability is much less than that given by Thomson's figures, and may (perhaps) be looked on as a vanishing quantity; the corresponding part of the isothermal being a finite line parallel to the axis of pressures, corresponding to the sudden absorption or giving out of latent heat."

[1] *Proc. Roy Soc. Edin.*, vol. vii. p. 63, 1870.

ON EVAPORATION AND CONDENSATION.

"While I was communicating my Note on the *Necessity for a Condensation Nucleus* at the last meeting of the Society, an idea occurred to me which germinated (on my way home) to such an extent that I sent it off by letter to Professor J. Thomson that same night.

"J. Thomson's idea, which I had been discussing, was to preserve, if possible, physical (as well as geometrical) *continuity* in the isothermal of the liquid-vapour state, by keeping the *whole* mass of fluid in one state throughout. He secured geometrical, but not physical, continuity. For, as Clerk-Maxwell showed, one part of his curve makes pressure and volume increase simultaneously, a condition essentially unstable. The idea which occurred to me was, while preserving geometrical continuity, to get rid of the region of physical instability, *not* (as I had suggested in my former Note) by retaining Thomson's proposed finite maximum and minimum of pressure in the isothermal, while bringing them infinitely close together so far as volume is concerned, and thus restricting the unstable part of the isothermal to a finite line parallel to the pressure axis; but, *by making both the maximum and minimum infinite.* Geometrical continuity, of course, exists across an asymptote parallel to the axis of pressures; so that, from this point of view, there is nothing to object to. On the other hand, there is essentially physical discontinuity, in the form of an impassable barrier between the vaporous and liquid states, so long at least as the substance is considered as homogeneous throughout.

"It appeared to me that here lies the true solution of the difficulty. As we are dealing with a fluid mass essentially homogeneous throughout, it is clear that we are not concerned with cases in which there is a molecular surface-film.

"Suppose, then, a fluid mass, somehow maintained at a constant temperature (lower than its critical point), and so extensive that its boundaries may be regarded as everywhere infinitely distant, what will be the form of its isothermal in terms of pressure and volume?

"Two prominent experimental facts help us to an answer.

"*First.* We know that the interior of a mass of liquid mercury can be subjected to hydrostatic *tension* of considerable amount without rupture. The isothermal must, in this case, *cross* the line of volumes; and the limit of the tension would, in ordinary language, be called the cohesion of the liquid. I am not aware that this result has been obtained with water free from air; but possibly the experiment has not been satisfactorily made. The common experiment in which a rough measure is obtained of the force necessary to tear a glass plate from the surface of water is vitiated by the instability of the concave molecular film formed.

"*Second.* Aitken has asserted, as a conclusion from the results of direct experiment, that even immensely supersaturated aqueous vapour will not condense without the presence of a nucleus. This may be a solid body of finite size, a drop of water, or fine dust particles.

"Both of these facts fit perfectly in to the hypothesis, that the isothermal in question has an asymptote parallel to the axis of pressure; the vapour requiring (in the absence of a nucleus) practically infinite pressure to reduce it, without change of state or of temperature, to a certain finite volume; while the liquid, also without change of state or temperature, may by sufficient hydrostatic *tension* be made to expand almost to the same limit of volume.

"This limiting volume depends, of course, on the temperature of the isothermal; rising with it up to the critical point.

"The physical, not geometrical, discontinuity is of course to be attributed to the latent heat of vaporisation. The study of the adiabatics, as modified by this hypothesis, gives rise to some curious results.

"It is clear that the experimental realisation of the parts of the here suggested curve near to the asymptote, on either side, will be a matter of great difficulty for any substance. But valuable information may perhaps be obtained from the indications of a sensitive thermo-electric junction immersed in mercury at the top of a column which does not descend in a barometer tube of considerably more than 30 inches long, when the tube is suddenly placed at a large angle with the vertical; or from those of a similar junction immersed in water, when it has a concave surface of great curvature from which the atmospheric pressure is removed.

"Nothing of what is said above will necessarily apply when we have vapour and liquid in presence of one another, or when we consider a small portion of either in the immediate neighbourhood of another body. For then we are dealing with a state of stress which cannot, like hydrostatic pressure or tension, be characterized (so far as we know) by a single number. The stress in these molecular films is probably one of tension in all directions parallel to the film, and of pressure in a direction perpendicular to it. Thus it is impossible to represent such a state properly on the ordinary indicator diagram. This question is still further complicated by the possibility that the difference between the internal pressures, in a liquid and its vapour in thermal equilibrium, may be a very large quantity."

As soon as I heard of Berthelot's experiment, I had it successfully repeated in my laboratory; and I considered that it afforded very strong confirmation of the hypothesis advanced in the last preceding extract.

But since I have been led to believe that there is probably truth in Laplace's statement as to the very great molecular pressure in liquids, I have still further modified the speculation. I now propose to take away the new asymptote, and make

the two branches of the isothermal join one another by what is practically a part of that asymptote:—thus making the liquid and the vaporous stages continuous with one another by means of a portion very nearly straight and parallel to the pressure axis. Somewhere on this will be found one of the points of inflection of the isothermal, the other being at a somewhat smaller volume, and at a pressure which is moderate for temperatures close to, but under, the "critical point," but commences to increase with immense rapidity as the temperature of the isothermal is lowered. *All* the isothermals will now present the same general features, dependent on the existence of two asymptotes and two points of inflection, whether they be above or below the critical point; but their form will be modified in different senses above and below it. The portion of the curve which is convex upwards will be nearly horizontal at the critical point, and will become steeper both above and below it; but pressure and volume will nowhere increase together. This suggestion, of course, like that in the second extract above, is essentially confined to the case of a fluid mass which is supposed to have no boundaries; for their introduction at once raises the complex difficulties connected with the surface-skin. Thus it will be seen that the conviction that water has large molecular pressure has led me back to what is very nearly the first of the two hypotheses I proposed.

A practical application of some of the principles just discussed is described in the following little paper:—

ON AN APPLICATION OF THE ATMOMETER.[1]

"The Atmometer is merely a hollow ball of unglazed clay, to which a glass tube is luted. The whole is filled with boiled water, and inverted so that the open end of the tube stands in a dish of mercury. The water evaporates from the outer surface of the clay (at a rate depending partly on the temperature, partly on the dryness of the air), and in consequence the mercury rises in the tube. In recent experiments this rise of mercury has been carried to nearly 25 inches during dry weather. But it can be carried much farther by artificially drying the air round the bulb. The curvature of the capillary surfaces in the pores of the clay, which supports such a column of mercury, must be somewhere about 14,000 (the unit being an inch). These surfaces are therefore, according to the curious result of Sir W. Thomson (Proc. Roy. Soc. Edin., p. 63, 1870), specially fitted to absorb moisture. And I found, by inverting over the bulb of the instrument a large beaker lined with moist filter-paper, that the arrangement can be made extremely sensitive. The mercury surface is seen to become flattened the moment the beaker is applied, and a few minutes suffice to give a large descent, provided the section of the tube be small, compared with the surface of the ball.

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 116, 117, 1885

"I propose to employ the instrument in this peculiarly sensitive state for the purpose of estimating the amount of moisture in the air, when there is considerable humidity; but in its old form when the air is very dry. For this purpose the end of the tube of the atmometer is to be connected, by a flexible tube, with a cylindrical glass vessel, both containing mercury. When a determination is to be made in moist air, the cylindrical vessel is to be lowered till the difference of levels of the mercury amounts to (say) 25 inches, and the diminution of this difference in a definite time is to be carefully measured, the atmospheric temperature being observed. On the other hand, if the air be dry, the difference of levels is to be made *nil*, or even negative, at starting, in order to promote evaporation. From these data, along with the constant of the instrument (which must be determined for each clay ball by special experiments), the amount of vapour in the air is readily calculated. Other modes of observation with this instrument readily suggest themselves, and trials, such as it is proposed to make at the Ben Nevis Observatory during summer, can alone decide which should be preferred."

APPENDIX F.

THE MOLECULAR PRESSURE IN A LIQUID.

LAPLACE'S result, so far as concerns the question raised in the text, may be stated thus. If $MM'\phi(r)$ be the molecular force between masses M, M′ of the liquid, at distance r, the whole attraction on unit mass, at a distance x within the surface, is

$$X = 2\pi\rho\int_x^\infty r\,dr\int_r^\infty \phi(r)\,dr,$$

where ρ is the density of the liquid. The density is supposed constant, even in the surface-skin. As we are not concerned with what are commonly called capillary forces, the surface is supposed to be plane.

The pressure, p, is found from the ordinary hydrostatic equation

$$\frac{dp}{dx} = \rho X.$$

Hence the pressure in the interior of the liquid is

$$K = \rho\int_0^a X\,dx,$$

where a is the limit at which the molecular force ceases to be sensible.

But the expression for K is numerically the work required to carry unit volume of the liquid from the interior, through the skin, to the surface. It is easy to see that the further work, required to carry it wholly out of the range of the molecular forces, has precisely the same value. Thus the whole work required to carry, particle by particle, a cubic inch of the liquid from the interior to a finite distance from its surface is

$$2K \times 1 \text{ cub. in.}$$

This investigation assumes ρ to be constant throughout the liquid, and thus ignores the (almost certain) changes of density in the various layers of the surface-skin; so that its conclusions, even when the question is regarded as a purely statical one, are necessarily subject to serious modification. With our present knowledge of the nature of heat, we cannot regard this mode of treatment as in any sense satisfactory.

APPENDIX G.

EQUILIBRIUM OF A COLUMN OF WATER.

First, suppose the temperature to be the same throughout. Let a be the whole depth, ρ_0 the density, on the supposition that gravity does not act. Then, if ρ be the density at the distance ξ from the bottom, when gravity acts, we have by the hydrostatic equation

$$\frac{dp}{d\xi} = -g\rho = -g\rho_0 \frac{1}{1 - \dfrac{Ap}{\Pi + p}}$$

if we adopt the rough formula of Section VII. for the compressibility. The integral is

$$p(1-A) + A\Pi \log.(\Pi + p) = C - g\rho_0\xi.$$

Now the conditions are—

(1) $\xi = \xi_0$ (the altered depth), $p = 0$;

(2) $\xi = 0$, $p = g\rho_0 a = \varpi$ suppose.

So that

$$\xi_0 = a(1-A) + \frac{A\Pi}{g\rho_0} \log. \frac{\Pi + g\rho_0 a}{\Pi}$$

$$= a(1-A) + \frac{A\Pi a}{\varpi} \log. \left(1 + \frac{\varpi}{\Pi}\right)$$

Since, even in the deepest sea, ϖ/Π is not greater than $1/6$, we may expand the logarithm in ascending powers of this fraction. We thus obtain

$$\xi_0 = a - aA\left\{1 - \frac{\Pi}{\varpi}\left(\frac{\varpi}{\Pi} - \frac{\varpi^2}{2\Pi^2} + \frac{\varpi^3}{3\Pi^3} - \dots\right)\right\}$$

$$= a - aA\left\{\frac{\varpi}{2\Pi} - \frac{\varpi^2}{3\Pi^2} + \dots\right\}$$

The second term is the diminution of depth required. We may write it, with change of sign, as

$$\frac{A}{2\Pi} g\rho_0 a^2 \left(1 - \frac{2\varpi}{3\Pi} + \frac{\varpi^2}{2\Pi^2} - \&c.\right)$$

As the factor A/Π stands for what is called e in the text, the first term is the

result given in the text; and the others show how it is modified by taking account of the diminished compressibility at the higher pressures.

Of course we might have employed the more exact formulæ, (A) or (B) as the case may be, but for all practical applications the rough formula suffices.

It might be interesting to study the effect on the mean level of a lake due to the indirect as well as the direct results of change of temperature. Heating of the water throughout, if there be a case of the kind, would increase the depth not only in consequence of expansion (provided the temperature were nowhere under the maximum density point), but also in consequence of the diminution of compressibility which it produces. Thus there would be an efficient cause of variation of depth with the seasons, altogether independent of the ordinary questions of supply from various sources and loss by evaporation.

If the temperature be not constant for all depths, ρ_0, ρ, and A are functions of ξ. Substituting their values in the hydrostatic equation, we must integrate it and determine the constant by the same conditions as before.

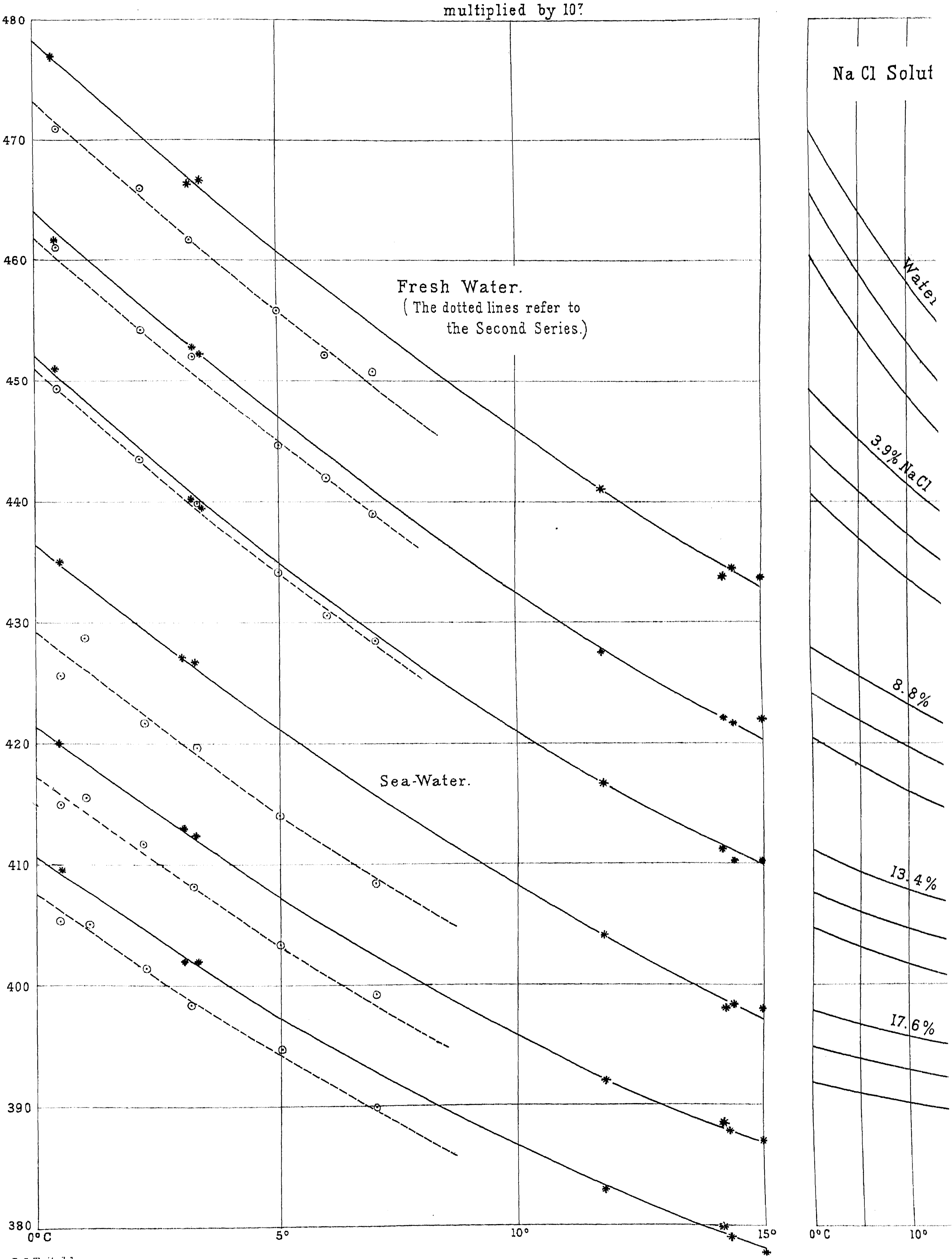
The condition for stable equilibrium is merely that $d\rho/d\xi$ shall not be anywhere positive. Until some definite problem is proposed, no more can be done with the equation.

[29/10/88.—At Dr. Murray's request I have calculated, from the data given in his paper: On the Height of the Land, and the Depth of the Ocean (Scottish Geographical Magazine, vol. iv. pp. 1–41, 1888), that the whole depression of the ocean level, due to compression, is about

116 feet only.

If water ceased to be compressible, the effect would be to submerge some 2,000,000 square miles of land, about 4 per cent. of the whole.]

AVERAGE APPARENT COMPRESSIBILITIES for 1, 2, & 3 TONS, multiplied by 10^7



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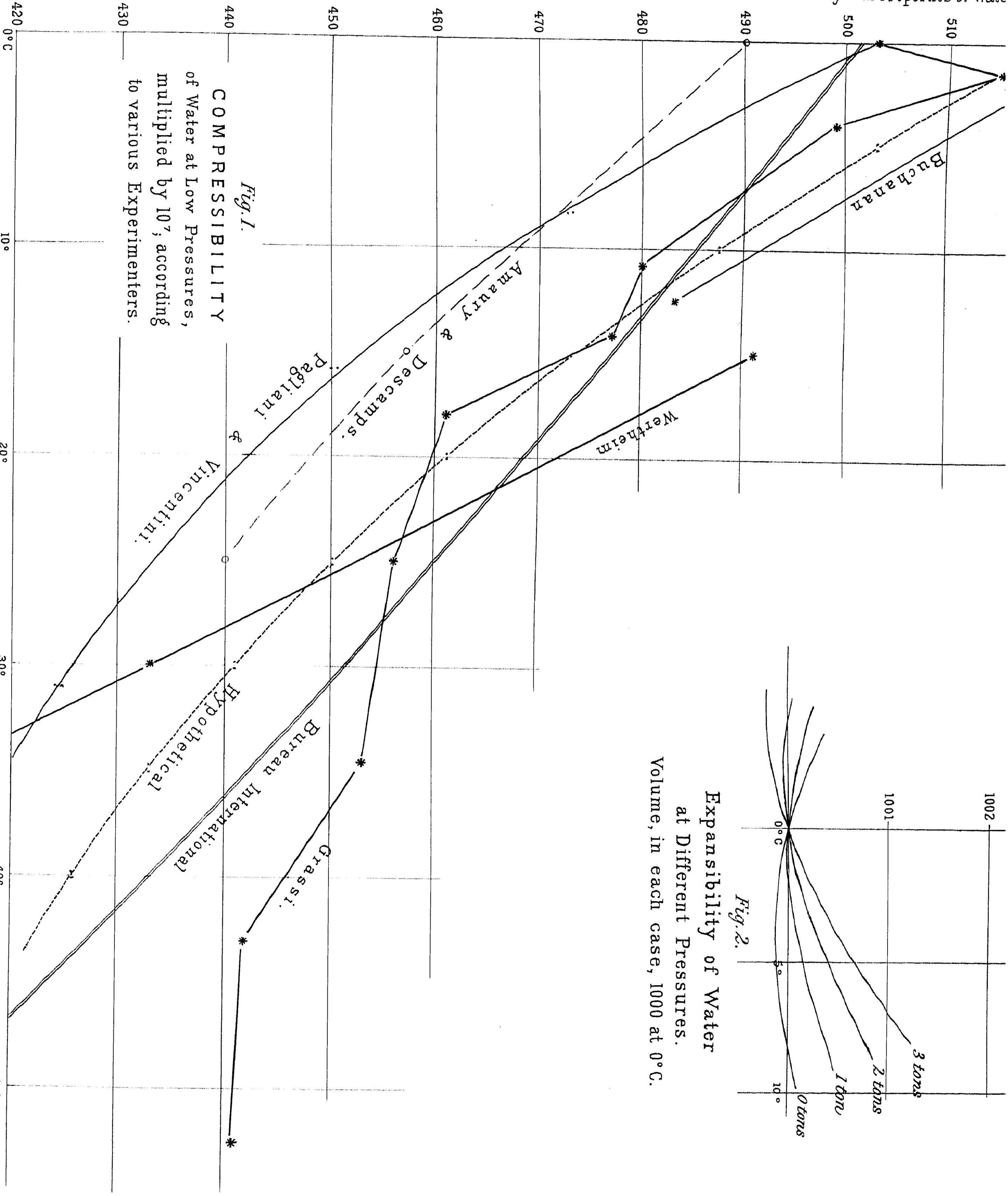
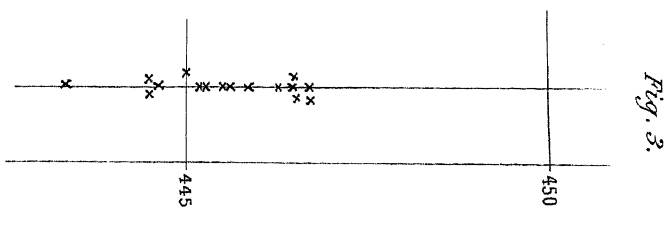




Observations of Apparent Average Compressibility of Water for 305 Atmospheres at 5° C, multiplied by 10⁷. 29 & 30/12/87.

P. G. Tait del. F. Huth, L.

THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on Atmospheric Circulation based on the Observations made on board H.M.S. Challenger during the years 1873-1876, and other Meteorological Observations. By Alexander Buchan, M.A., LL.D., Secretary of the Scottish Meteorological Society.

In the Narrative of the Cruise of the Challenger, vol. ii. pp. 300 to 304, the conditions are detailed under which the meteorological observations were made during the voyage, and the observations themselves are printed *in extenso*, pp. 305 to 744.

The instruments employed, which had been previously verified, were furnished by the Meteorological Department of the Board of Trade. The observations were uniformly made at two-hourly intervals, except when the Challenger was in Sub-Antarctic waters, from December 21st, 1873, to March 17th, 1874, the observations being then made every hour.

Temperature.—The dry and wet bulb thermometers were, in the early part of the voyage, suspended in the small screen provided by the Meteorological Department, which was fastened to the after upright of the steering wheel, under the pilotage bridge; but as this screen was too small to contain a maximum and minimum thermometer in addition to the dry and wet bulbs, a larger one was con-

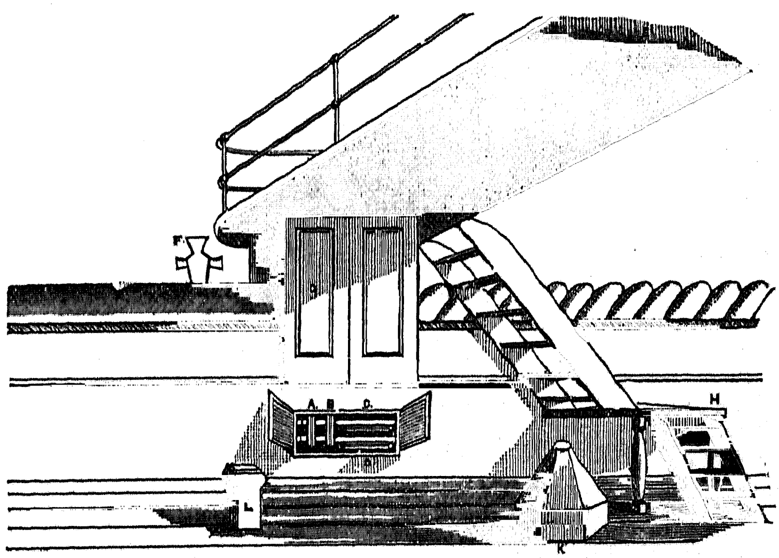


Fig. 1.—Showing position of Thermometers.

A, dry bulb thermometer; B, wet bulb thermometer; C, maximum thermometer; D, minimum thermometer; E, pilotage bridge; F, bollard for boat's fall; G, signal locker; H, platform and ladders leading to bridge; K, skylight over naturalists' workroom; L, towing bollard.

structed and placed against the ship's side, under the shade of the pilotage bridge, as represented in Fig. 1 supplied by Staff-Commander Tizard, R.N. The change was effected on April 17th, 1873, the thermometers being separated from the ship's side by wooden battens about three inches in thickness, and the maximum and minimum thermometers were hung from the same battens. The thermometers were occasionally tested for error of zero points, in melting ice, and further with a standard thermometer by Geisler.

The relative humidity was deduced from the dry and wet bulb readings by Glaisher's Hygrometrical Tables, sixth edition.

The temperature of the surface of the sea was obtained by drawing a bucket of water from over the side of the ship, and immersing a thermometer in it, care being taken that the water was obtained from a position sufficiently far forward to be clear of the discharge-pipes from the engines, etc. When in the region of ocean stream currents, the temperature of the surface water was taken at hourly or half-hourly intervals.

Atmospheric Pressure.—The barometer was suspended on the main deck, just outside the captain's cabin, the cistern being 9½ feet above the level of the sea. The same barometer, which was used throughout, was compared with the standard at Kew before leaving and again on the return to England, and also with the barometers in the Observatories at the Cape of Good Hope, and at Sydney, N.S.W., its error remaining constant throughout the voyage. The readings have been corrected for all instrumental errors, and reduced to 32° and sea level. No correction for errors of observation were made in the observations printed in the "Narrative," but in this discussion of the results all evident errors of observation have been rectified.

Wind and Weather.—In accordance with the practice on board ship, the compass direction of the wind was recorded at the time of observation, but in the printed table its direction has been referred to the true meridian. In describing the force of the wind and state of the weather, the notation proposed by Admiral Beaufort was employed. This notation is explained in all elementary works on meteorology.

Clouds.—The amount recorded was in all cases estimated, 10 indicating a sky completely overcast and 0 a clear sky. Both the upper and lower clouds were recorded, and the notation of the species was that generally in use, being essentially Howard's classification.

Currents.—The direction and rate of the current was derived from the differences in the position of the ship at noon determined by astronomical observation and that determined by courses steered and distances run by patent log from the astronomical position of the preceding noon. Specific observations on the direction and rate of the surface currents were frequently made during the voyage, either from a boat fast to the trawl rope, or when the ship was kept stationary for sounding purposes, occasionally by comparing the distances shown by patent log with the distances made good over the

ground as ascertained by objects on shore. These several results, independent of the ship reckoning, are given in the account of the voyage. It has been disputed whether the difference in a day's run between the position of the ship by dead reckoning and by astronomical observation can be regarded as giving with sufficient accuracy the movement of the surface water. But the long experience of navigators proves that with due care this result furnishes a fair approximation to the truth, and especially so when the astronomical observations are made at frequent intervals during the twenty-four hours. Much care was taken during the voyage, by due attention to the steerage and estimation of the leeway, to keep an accurate reckoning, and also to ascertain frequently the latitude and longitude by astronomical observation. The surface set deduced by these means was found in the majority of cases to be continuous during the day, and to agree in a striking manner with the surface current, as found by anchoring a boat, or other direct method.

Specific Gravity of Sea Water.—The specific gravity of the sea water during the voyage was ascertained by Mr. Buchanan, the analytical chemist of the Expedition, with a delicate hydrometer, designed by him for this purpose, which is described in Physics and Chemistry, vol. i.

The most cursory glance suffices to show that the varying phenomena with which meteorology deals are all referable to the sun, it being evident that if the sun were blotted out from the sky, a cold lifeless uniformity would take possession of the whole surface of the earth. It is thus that all meteorological phenomena may be conveniently grouped into two great classes: those resulting from the revolution of the earth on its axis, and those resulting from its revolution round the sun taken in connection with the inclination of its axis to the plane of its orbit. Hence meteorology falls into two great divisions, the first embracing diurnal and the second annual phenomena.

Humboldt, Dove, Kuppfer, Quetelet, Sabine, Brewster, and the other early founders of the science, were keenly alive to the essential importance of hourly observations in the investigation of diurnal phenomena. By the influence they brought to bear on the Governments of the day, meteorological and magnetical Observatories of the first class were established widely over the civilised world, from which observational data were obtained that will always hold their place as contributions of the first importance to science.

On the basis of these observations the diurnal changes in atmospheric pressure, temperature, humidity, and wind were partially revealed and explained. It came, however, by and by to be felt that data supplied exclusively by Observatories on land were inadequate to a right conception and explanation of meteorological phenomena, and accordingly when the Challenger Expedition was fitted out, arrangements were made for taking, during the cruise, either hourly or two-hourly meteorological observa-

tions. These observations are by far the most complete yet made on the meteorology of the ocean.

In discussing the observations, the first step was to recopy the whole of them, arranged chronologically as observed, according to the hours of observation, a distinct set thus arranged being set apart for each of the subjects observed, viz. the barometer, dry bulb, wet bulb, maximum and minimum thermometers, wind, cloud, weather, squalls, thunder and lightning, and the temperature of the surface of the sea. The hourly values were then calculated for periods of time varying from three days to a month, and from these results hourly values for still longer periods were calculated, with the view of showing the distribution of the phenomena, as influenced by proximity to, or distance from, land, by latitude, by season, and in some cases by the extent of water surface presented by the five great oceans of the globe.

Diurnal Phenomena.

Variation of Temperature. — Of the daily changes which take place in the atmosphere, the first place must be assigned to those which relate to temperature, since on these changes all others are either directly or indirectly dependent. Observations of the temperature of the air, and of the water and land surfaces of the earth, are thus of fundamental importance in meteorology.

The sun's rays which fall on land and on solid bodies generally are wholly absorbed by the thin surface layer exposed to the heating rays, the temperature of which consequently rises. While the temperature of the surface thus increases, a wave of heat is propagated downwards through the soil. The intensity of this daily wave of temperature rapidly diminishes with the depth, so that it ceases to be measurable about four feet below the surface. Part of the heat thus imparted to the surface layers is conveyed away upwards by convection currents, which originate in the superheating of the lowermost stratum of air in direct contact with the heated surface of the land. At the same time colder currents descend from greater heights to fill the space left by the ascending currents.

Quite different, however, is the influence of the sun's rays on water. In this case the solar rays are very far from being altogether arrested at the surface, but penetrate to a very considerable depth. The heating effect of the sun has been shown by the observations of the Challenger to be distinctly appreciable to a depth of 500 feet below the surface of the sea.

The rate at which, in clear water, the heating effect takes place at different depths is a problem not yet worked out, being very difficult of even an approximate solution owing to the presence of the relatively large numbers of dust particles which even the clearest water contains. Since water is a bad conductor, the heat thus distributed

cannot be considered, as holds good in the case of land, to penetrate by conduction to greater depths, only doing so when increased densities, due to evaporation or other causes, carry the higher temperature to greater depths. The rate of diffusion downwards may be regarded as proportional to the vertical density gradient from the surface layers downward.

Hence the vital distinction between land and water surfaces in their bearings on climate lies in this, that nearly all the sun's heat falling on land is arrested on the surface, but as regards water it is at once transmitted downwards to great depths. In shallow water, the sun's heat raises the temperature much higher than in deep water, for the obvious reason that nearly all solar radiation falling on the surface raises the temperature of the shallow layer of water; in other words, the influence of the heat rays of the sun is concentrated on a small depth of water, instead of being diffused through a great depth. On the other hand, water more or less turbid by the presence of organic or inorganic matter, is more highly heated near the surface.

Surface Temperature of the Sea.—When it is considered that three-fourths of the earth's surface is water, that the temperature of the air resting on its surface is in closest relation to the temperature of the surface, and that the latter has, through the winds, direct and all-important bearings on the temperature of the land surfaces of the globe, it is at once seen to be impossible to overstate the importance of this datum of meteorology. It will also appear further on to have bearings equally important in the elucidation of the fundamental principles of the science.

Among the first, if not the first, contributions for determining the diurnal march of the temperature of the surface of the sea were those made by Captain Thomas, R.N., during the years 1859–63, while engaged on the survey of the islands on the north-west of Scotland. During this survey, observations of the temperature of the sea were made every hour of the day at all seasons, and with a frequency sufficient for the determination of the diurnal range of the temperature of the surface. From these observations it has been shown [1] that the daily minimum, 0°·17 below the mean,[2] occurred about 6 A.M.; the mean about 11 A.M.; the maximum, 0°·13 above the mean, between 3 and 4 P.M.; and the mean again shortly before 2 A.M. Hence the daily oscillation of the temperature of the open sea off the north-west of Great Britain is only 0°·3.

During the cruise, the temperature of the surface of the sea was observed every two hours as part of the scientific work of the Expedition. From these observations the deviations each two hours of the day from the mean daily temperature of the surface of the sea have been calculated, and the results are given in Table I., App. pp. 1–3. The periods for which the averages have been calculated are about five days, more or less, and in those cases in which the temperature at the beginning of the

[1] *Journal of the Scottish Meteorological Society*, vol. i. pp. 265–270.

[2] The temperatures in this Report are Fahrenheit.

period differed considerably from that at the close, a correction has been applied so as to give the true deviations from the daily means for the observed hours. It will be seen, from an examination of the Table, that in nearly all cases the short periods adopted give results closely approximate to the mean diurnal variations. In a very few cases, such as the period of six days from October 3 to 8, 1875, when the Challenger was in the South Pacific, mean position lat. 21° 20′ S., long. 149° 40′ W., the usual distribution of the daily temperature was reversed, the maximum occurring early in the morning, and the minimum early in the afternoon. All such anomalous results were due to the track of the Challenger at the time being across a succession of warm and cold currents, the differences of whose temperatures, combined with the hours of the day at which the observations were made, gave the curve of the diurnal variation for the period its anomalous character.

The diurnal variation of the temperature of the surface of the North Atlantic has been calculated from the observations made on the one hundred and twenty-six days from March to August 1873, and in April and May 1876, the mean latitude of all the points of observation being nearly 30° N. and the longitude 42°. The following are the two-hourly deviations from the mean (Plate I. fig. 1):—

2 A.M.	−0°·2	10 A.M.	0°·1	6 P.M.	0°·3
4 „	−0°·3	Noon	0°·2	8 „	0°·0
6 „	−0°·3	2 P.M.	0°·5	10 „	−0°·2
8 „	−0°·1	4 „	0°·5	Midt.	−0°·3

Thus in Mid Atlantic, about lat. 30° N., where the sun's heat is strong, and at the time of the year when the sun is north of the equator, the diurnal fluctuation of the temperature of the surface is only 0°·8. Similarly in the South Atlantic, lat. 33° S. and long. 20° W., the mean diurnal fluctuation is 0°·8, or the same as in the North Atlantic. In the North Pacific, near lat. 37° N. and long. 170° W., it is 1°·0; and in the South Pacific, near lat. 36° S. and long. 87° W., it is 0°·9. Hence the general diurnal range of temperature near the centres of these four great oceans, and near the summer solstice, is a little less than a degree. On the other hand, near the equator both in the Atlantic and Pacific the diurnal range is only 0°·7, being thus 0°·2 less than about lat. 36°, a difference probably due to the more clouded skies and less sunshine of equatorial regions. In February 1874, when the mean position of the Challenger was nearly lat. 61° S., the difference between the mean coldest and warmest hour was only 0°·2. The mean daily range deduced from the whole of the observations made during the three years and a half is 0°·8.

The small daily variation of the temperature of the surface of the sea shown by the Challenger observations is unquestionably a most important contribution to physical science, forming in truth one of the prime factors in meteorology, particularly, as will appear further on, in the discussions relating to atmospheric pressure and winds.

Temperature of the Air over the Open Sea.—Table II., App. pp. 4–6, which has been constructed similarly to Table I., shows the deviations each two hours from the mean daily temperature of the air as observed on board the Challenger. The following figures show the daily march of the temperature of the air over the North Atlantic on a mean of the same one hundred and twenty-six days for which the temperature of the sea has been given (Plate I. fig. 2):—

2 A.M.	−1°·1	10 A.M.	0°·8	6 P.M.	0°·7
4 "	−1°·4	Noon	1°·4	8 "	−0°·3
6 "	−1°·4	2 P.M.	1°·8	10 "	−0°·8
8 "	−0°·2	4 "	1°·6	Midt.	−1°·0

The amplitude of the daily fluctuation is thus 3°·2. In the South Atlantic, about lat. 36° S. and long. 36° W., the diurnal range of temperature is 2°·5; in the North Pacific, about lat. 37° N. and long. 168° W., 3°·1; and in the South Pacific, about lat. 36° S. and long. 100° W., 4°·0. In the neighbourhood of the equator in the Atlantic, about long. 18° W., the daily range is 2°·6, and in the Pacific, about long. 145 E., 2°·1. Hence while the mean daily range of temperature of the air in the anti-cyclonic regions of the four great oceans is 3°·2, in the neighbourhood of the equator, where the sky is more clouded, it is about a degree less. In high latitudes the daily range is much less, as will appear from the following table:—

Number of Days' Obs.	Lat. S.	Long. E.	Daily Range of Temp. of Air.
18	62° 40′	85° 26′	0°·8
10	54° 5′	73° 14′	1°·8
10	51° 54′	117° 47′	1°·5
6	47° 16′	56° 23′	1°·9

The general result is that the daily range of the temperature of the air on the open sea is from three to four times greater than that of the surface temperature of the sea over which it lies.

Part of this increased daily range of the temperature of the air as compared with that of the sea was no doubt occasioned by a higher temperature during the day and a lower during the night on the deck of the Challenger as compared with that of the free atmosphere over the sea all round. But, after making allowance for this disturbing influence, it may be assumed that the temperature of the air has a considerably larger daily range than that of the sea on which it rests. The point is one of no little interest in atmospheric physics from its important bearings on the relations of the air and its watery vapour, in its gaseous, liquid, and solid states, and of the particles of dust everywhere present, to solar and terrestrial radiation.

During the same months, which gave on the mean of one hundred and twenty-six days a daily range of temperature of 3°·2 over the open sea, the Challenger was lying near land on seventy-six days. The observations made on these days showed a greater daily range than out on the open sea. The minimum, −2°·1, occurred at 4 A.M., and the maximum, 2°·3, at noon, thus giving a daily range of 4°·4. It is interesting to note the frequency with which the mean daily maximum occurred as early as noon when the Challenger was in harbour, a result probably due to the diurnal period of the sea breezes in such situations in tropical and subtropical regions. Generally speaking, at High Level Stations and in situations within the influence of well-marked sea breezes, the time of occurrence of the daily maximum temperature is about two hours earlier than in inland open situations.

Brewster made the remark many years ago, that, as regards land observations, the mean of any pair of hours of the same name, such as 2 A.M. and 2 P.M., 4 A.M. and 4 P.M., etc., does not differ very materially from the mean temperature of the day.

The following are the deviations from the mean temperature of the air of the separate pairs of hours for the one hundred and twenty-six days of the North Atlantic given above :—

	Deviation from the Mean.
2 A.M. and 2 P.M.,	+0°·3
4 ,, ,, 4 ,,	+0°·1
6 ,, ,, 6 ,,	−0°·3
8 ,, ,, 8 ,,	0°·0
10 ,, ,, 10 ,,	0°·0
Noon and midnight,	+0°·2

The result for the six hours, 4, 8 A.M. and P.M., noon and midnight, is +0°·1, and for the six hours 2, 6, and 10 A.M. and P.M., 0°·0.

In the Isothermal Maps for the globe given in this work, the isothermals for the North Atlantic have been drawn from the data published in the "International Meteorological Observations" of the United States. But as the observations are made as near as possible at the same physical instant, they were first corrected for Diurnal Range from the results given in this table.

Variation of the Humidity of the Air.—The observations on the humidity of the atmosphere were made with the ordinary dry and wet bulb thermometers, from which the absolute and relative humidities have been calculated by Glaisher Tables.

If the aqueous vapour remained permanently and unchanged in the atmosphere, that is, if it were not liable to be condensed into cloud or rain, the mixture would become as complete as that of the oxygen and nitrogen of the air. The equilibrium of the vapour atmosphere, however, is being constantly disturbed by changes of temperature, by every instance of condensation, and by the unceasing process of evaporation. Since

dry air materially obstructs the free diffusion of the aqueous vapour, the law of the independent pressure of the vapour and the dry air of the atmosphere holds good only approximately. The aqueous vapour, however, constantly tends to approach this state. The important conclusion follows, that the hygrometer can never indicate more than the local humidity of the place where it is observed. While then in certain cases the amount of vapour indicated by the dry and wet bulb readings is far from the truth, yet in averages, particularly long averages, a close approximation to the real humidity of the locality is attained if the hygrometer be at all tolerably well exposed and carefully manipulated and observed.

Aqueous vapour is being constantly added to the air from water, snow, and other moist and frozen surfaces. The rate of evaporation is greatest when the air is driest or freest from vapour, and least when it is nearest the point of saturation. As air expands under a diminished pressure, its temperature consequently falls, and it continues to approach nearer the point of saturation, or to become moister; and as it contracts under an increased pressure, its temperature rises, and it recedes from the point of saturation, or becomes drier. Hence ascending currents of air become moister with every addition to the ascent, and descending currents drier as they continue to descend.

The pressure exerted by the aqueous vapour in the atmosphere, or, as it is usually called, the elastic force of vapour, is expressed in decimals of an inch of the mercurial barometer. It indicates the quantity of aqueous vapour in the air at the place of observation, and in this light may be viewed as the absolute humidity of the air as there observed. It cannot, however, be regarded as indicating the pressure due to the aqueous vapour of the whole atmosphere over the place of observation, since we are still very ignorant of the distribution of the aqueous vapour with height. Now the diurnal variation in the elastic force of vapour in the air is seen in its simplest form over the open sea. Grouping together all the hygrometric observations made on board the Challenger in the North Atlantic, at a distance from land, from March to July 1873, eighty-four days in all, there being for that time a mean elastic force of 0·659 inch, the following is the diurnal variation (Plate I. fig. 3):—

	Inch.		Inch.		Inch.
2 A.M.	−0·015	10 A.M.	+0·004	6 P.M.	+0·007
4 „	−0·020	Noon	+0·017	8 „	+0·002
6 „	−0·016	2 P.M.	+0·020	10 „	−0·005
8 „	−0·007	4 „	+0·017	Midt.	−0·010

Thus the minimum, −0·020 inch, occurs at the hour when the temperature of the surface of the sea and air resting over it falls to the daily minimum; it then rises to the mean a little after 9 A.M.; to the daily maximum, +0·020 inch, at 2 P.M., when the temperature of the sea and air are also near the daily maximum; and falls to the mean

shortly before 9 P.M. But it is only on the open sea, at a distance from land, where this typical curve of the diurnal humidity occurs with its single minimum and maximum. Over land the humidity daily curve shows two well-marked minima and maxima—the two minima occurring in the early morning and in the afternoon; and the more inland the situation and stronger the sun, the more strongly marked is the afternoon minimum. Now the hygrometric observations made near land show a daily humidity curve intermediate between these two. The observations made near land in the North Atlantic, during the same months, disclose the following diurnal variations (Plate I. fig. 4):—

	Inch.		Inch.		Inch.
2 A.M.	−0·003	10 A.M.	+0·014	6 P.M.	0·000
4 "	−0·009	Noon	+0·010	8 "	−0·004
6 "	−0·010	2 P.M.	+0·007	10 "	−0·005
8 "	−0·003	4 "	+0·015	Midt.	−0·007

The disturbance due to proximity to land in the diurnal distribution of the aqueous vapour in the lower stratum of the atmosphere is remarkable. The maximum and minimum no longer follow the corresponding phases of the temperature of the surface of the sea and the air. The disturbing agents are the land and sea breezes, with the other atmospheric movements resulting from the unequal heating of land and water. Under the influence of the land breeze, the time of minimum humidity is delayed till about 6 A.M. The most remarkable feature of the curve, however, is the occurrence of a secondary minimum of humidity, for some hours between 10 A.M. and 4 P.M., a feature altogether absent in the atmosphere over the open sea. It is to be noted that this mid-day minimum occurs at the hours of the day when, the surface of the land being most highly heated, the ascending current of heated air rising from it is strongest, and the resulting breeze from the sea towards the land therefore also strongest. This diminution in the amount of aqueous vapour, recorded on board the Challenger when near land, points unmistakably to an intermixture, with the air forming the sea breeze, of descending thin air filaments or currents to take the place of the masses of air removed by the currents which ascend from the heated surface of the land; and this increased dryness occurs also in the air of the sea breezes as they near the land.

The relative humidity of the air, or, as it is more frequently called, its humidity, is the degree of its approach to complete saturation. Complete saturation is represented by 100, and air absolutely free of vapour by 0. The latter, however, never occurs in the free atmosphere. About the lowest relative humidity, or driest state of the atmosphere hitherto recorded with the requisite care and accuracy, was 6 per cent. at the Ben Nevis Observatory at 8 P.M. of March 12, 1886, on which day the mean of the twenty-four hourly observations was only 15 per cent.

The diurnal variation of the relative humidity, which is quite different from that

of the vapour pressure, is of the simplest description. The following are the deviations from the mean daily humidity, 80 per cent., over the North Atlantic, from the observations made on that ocean in 1873 (Plate I. fig. 5):—

	Per cent.		Per cent.
2 A.M.	+2	2 P.M.	−3
4 „	+2	4 „	−2
6 „	+1	6 „	−1
8 „	0	8 „	0
10 „	−1	10 „	+1
Noon	−2	Midt.	+2

Hence the maximum humidity takes place from midnight to 4 A.M., and the minimum from noon to 4 P.M., in other words, when the temperature of the air is at the daily minimum and maximum respectively, the curve of humidity being thus simply inverse to that of the temperature. These are, substantially, the prominent phases of the curve of humidity for all climates and seasons, subject, however, to a slight increase in sea-side climates during the hours of the day of the prevalence of the sea breeze.

The significance of this constituent of climate lies in its relations to the diathermancy of the air, and to the dust particles everywhere present in it, and consequently to the all-important questions of solar and terrestrial radiation. It is assumed, with high probability, that perfectly pure and dry air, or air quite free from aqueous vapour and dust particles, permits rays of heat to pass through it with at most no more than a very slight increase to its temperature. We are yet without exact information as to whether a mixture of the air with aqueous vapour as a pure gas only, is equally diathermanous with dry air. Whether this be so or not, it may be regarded as certain that the atmosphere never interposes between the earth and the sun a purely gaseous aerial screen, but that it everywhere, even when apparently quite clear, contains minute particles of dust, and water either in the fluid state, or in the solid state as small spicules of ice.

Next to the winds, the aqueous vapour of the air, in its amount and relation to solar and terrestrial radiation, and in the different ways in which in different localities it is partitioned through the hours of the day and months of the year, plays the most important part in giving to the various regions of the globe their infinitely diversified climates.

Oscillations of the Barometer. Tables III. and IV., App. pp. 7–48.—The general character of the diurnal oscillations of atmospheric pressure is shown by figs. 6 and 7 of Plate I. Fig. 6 represents the mean oscillation for Batavia, lat. 6° 11′ S., long. 106° 50′ E., and fig. 7 a strictly ocean oscillation in the Pacific in lat. 1° 10′ S. and long. 150° 46′ W. Both figs. show two maxima about 10 A.M. and 10 P.M., and two minima about 4 A.M. and 4 P.M. respectively. The two situations are near the equator, the one on the coast of Java and the other in mid ocean. In the latter the

phenomena are shown in their simplest form, whilst at Batavia the more striking effects of the influence of land are apparent.

In order to show the constancy, or otherwise, of the times of occurrence of the maxima and minima, a series of twelve maps of the globe were prepared for the month of June, showing at all stations from which the required data have been obtained, the deviations at noon, 2 P.M., 4 P.M., etc., G.M.T., from the daily mean pressure; and thence four lines were drawn showing the places where, at that hour, the maxima and minima occurred. For fully 30° north and south of the equator the lines of maxima and minima ran north and south, but in higher latitudes these lines are changed, particularly as regards the forenoon maximum and the afternoon minimum. For example, at 6 P.M. the line indicating the afternoon minimum is for the latitude of London in long. 16° W.; in lat. 30° N., it is in long. 35° W., in which meridian it holds its course southwards as far as lat. 30° S.; its course thence turns south-westwards to near the Falkland Islands, long. 60° W. It follows that in June the afternoon minimum occurs about three hours earlier in the Falkland Islands than in the south-west of Ireland, thus showing in a striking manner the influence of season on the diurnal phenomena of pressure. In cases where the lines of maxima and minima cross such regions as southern and western Europe, whose surface is diversified by large tracts of land and sheets of water, the deflexions are peculiarly striking and instructive.

In middle and higher latitudes in summer, proximity to the sea, conspicuously so when the station is situated on the west coasts of continents and islands, delays the time of occurrence of the morning maximum and the afternoon minimum; whilst in continental situations the morning maximum occurs much earlier than in lower latitudes, and the evening minimum nearly as late as at places near the sea. It appears from the Challenger observations that these peculiarities of the curves do not occur over the open sea in the higher latitudes.

The retardation of the time of occurrence of the morning maximum is greatest in situations which, while strongly insular in character, are at the same time on, or not far from, an extensive tract of land to eastward or south-eastward. This is well illustrated by the hourly oscillations of the barometer for the year at Helder, in the north-west of Holland, and Sitka, in the south-east of Alaska (Table IV., App. pp. 28 and 36). The deviations from the means are given in thousandths of an inch.

It is seen that at Helder, the morning maximum occurs at times varying from nine to ten o'clock in the beginning of the year, and successively later as the year advances, till in June it is delayed to 2 P.M., and thereafter it occurs earlier and earlier month by month till January, when it is at the earliest. The following selected cases of the hourly deviations of pressure in June illustrate the gradual occurrence earlier of this phase according as the place becomes less insular as described above, the series closing with Kew and Culloden, to which are added Katherinenburg and Fort Rae. A selection of these is plotted on Plate I., figs. 8–15.

TABLE SHOWING THE DIURNAL OSCILLATION OF THE BAROMETER IN JUNE, IN THOUSANDTHS OF AN INCH.

The Heavy Figures show a pressure above, the Italic Figures below, the Means.

	Sitka.	Helder.	Keitum.	Valentia.	Falmouth.	Amsterdam.	Wustrow.	Neufahrwasser.	Pola.	Helsinfors.	St. Petersburg.	Hamburg.	Kew.	Culloden.	Katherinenburg.	Fort Rae.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Lat. N.	57 3	52 57	54 54	51 55	50 9	52 22	54 21	54 24	44 52	60 14	59 56	53 33	51 28	57 29	56 49	62 39
Long.	−135 18	4 40	8 22	−10 18	−5 4	4 53	12 24	18 40	13 50	24 57	30 16	9 58	−0 19	−4 8	60 38	−115 44
1 A.M.	**1**	*4*	*0*	**1**	*2*	**5**	*2*	**3**	*2*	**5**	*0*	**1**	**5**	**8**	**5**	**1**
2 ,,	*1*	*11*	*5*	*7*	*10*	*3*	*7*	*3*	*5*	*2*	*0*	*5*	**2**	**3**	**5**	**2**
3 ,,	*2*	*17*	*9*	*14*	*17*	*10*	*11*	*8*	*10*	*6*	*0*	*6*	*2*	**3**	**4**	**2**
4 ,,	*5*	*18*	*12*	*20*	*20*	*12*	*11*	*10*	*11*	*6*	*1*	*5*	*1*	**4**	**4**	**4**
5 ,,	*6*	*17*	*13*	*19*	*19*	*12*	*10*	*10*	*7*	*4*	*0*	*2*	**2**	**4**	**5**	**6**
6 ,,	*6*	*13*	*12*	*16*	*14*	*10*	*6*	*6*	*3*	*1*	*0*	**2**	**6**	**5**	**6**	**9**
7 ,,	*7*	*7*	*9*	*12*	*8*	*7*	*1*	*2*	**2**	**1**	**2**	**6**	**10**	**5**	**8**	**10**
8 ,,	*6*	*4*	*7*	*7*	*3*	*3*	**4**	**0**	**9**	**5**	**3**	**11**	**12**	**5**	**8**	**11**
9 ,,	*6*	*0*	*4*	*3*	*0*	**0**	**7**	**3**	**12**	**8**	**5**	**12**	**11**	**4**	**8**	**11**
10 ,,	*4*	**3**	**1**	**1**	**2**	**3**	**10**	**5**	**16**	**9**	**7**	**11**	**9**	**0**	**5**	**9**
11 ,,	*1*	**4**	**4**	**5**	**6**	**4**	**11**	**5**	**17**	**11**	**7**	**9**	**6**	*1*	**2**	**8**
Noon	**3**	**4**	**5**	**7**	**7**	**9**	**10**	**6**	**18**	**11**	**7**	**5**	**2**	*4*	*1*	**6**
1 P.M.	**4**	**9**	**7**	**7**	**7**	**8**	**7**	**4**	**11**	**9**	**5**	**2**	*5*	*7*	*5*	**3**
2 ,,	**6**	**11**	**7**	**6**	**6**	**6**	**5**	**2**	**5**	**5**	**2**	*2*	*10*	*7*	*7*	**1**
3 ,,	**6**	**7**	**7**	**6**	**5**	**4**	**4**	**0**	*1*	**1**	**0**	*5*	*13*	*8*	*9*	*3*
4 ,,	**6**	**5**	**5**	**4**	**3**	**2**	**1**	*1*	*7*	*2*	*2*	*10*	*17*	*11*	*13*	*8*
5 ,,	**4**	**3**	**2**	**3**	**1**	*1*	*1*	*3*	*13*	*5*	*5*	*13*	*20*	*11*	*15*	*10*
6 ,,	**3**	**2**	**2**	**4**	**2**	*2*	*3*	*3*	*15*	*6*	*7*	*13*	*18*	*6*	*13*	*12*
7 ,,	**1**	**4**	**2**	**5**	**3**	*2*	*4*	*4*	*13*	*6*	*7*	*10*	*12*	*3*	*11*	*13*
8 ,,	**1**	**5**	**3**	**7**	**5**	**3**	*4*	*1*	*9*	*6*	*7*	*6*	*4*	**3**	*5*	*13*
9 ,,	**3**	**11**	**7**	**9**	**13**	**9**	*1*	**5**	*1*	*5*	*4*	**1**	**6**	**6**	**1**	*10*
10 ,,	**3**	**10**	**8**	**14**	**14**	**11**	**2**	**5**	**2**	**2**	*3*	**3**	**11**	**6**	**5**	*7*
11 ,,	**4**	**7**	**7**	**11**	**11**	**12**	**1**	**6**	**3**	**4**	*1*	**4**	**12**	**7**	**6**	*5*
Midt.	**2**	**7**	**4**	**6**	**9**	**8**	*2*	**3**	**1**	**5**	*0*	**3**	**10**	**6**	**6**	*2*

In the British islands, the curve most characteristic of insular climates is that of Valentia, and that most characteristic of continental climates is the curve for Culloden, these two curves being nearly throughout the reverse of each other. The times of occurrence of the morning maximum are respectively 1 P.M. and 7 A.M., or six hours apart. A comparison of the curves for Kew and Culloden, and of these with the curves for Katherinenburg and Fort Rae, in the interior of the continents of Asia and North America respectively, is very interesting. In insular situations, the morning minimum is unusually large, whilst the afternoon minimum becomes, in the more strictly insular situations, so small as almost to disappear; but, on the other hand, in continental situations, the afternoon minimum is strongly pronounced, whilst the morning minimum tends to vanish, and in many cases disappears altogether,—of which Fort Rae is an example (fig. 15),—thus reducing the phenomena to one daily tide.

It is to be specially noted that the morning maximum attains the time of greatest retardation in June, when the sun is highest in the heavens, and not in July, when nearly all meteorological conditions show one of their two most prominent annual phases. From this result, the important conclusion follows that the phenomena of the diurnal barometric range are not cumulative, but that in their relation to the sun they

are direct. The movement from east to west is only quasi-tidal, being quite different from the manner in which the tides of the ocean are propagated from place to place over the earth's surface. The barometric tides are in truth directly generated by solar and terrestrial radiation in the regions where they occur, and it is in this way that the great variation revealed by observation in the curves of restricted districts comparatively near each other are to be explained.

From hourly observations made in June at the base, the top, and two intermediate points on Mount Washington, N.H. (Table IV. p. 48, and Plate I. figs. 16–19), it is seen that the time of occurrence of the morning maximum at the base of the mountain, 2898 feet above the sea, was 8 A.M.; at 4059 feet, 10 A.M.; at 5533 feet, 11 A.M.; and at the top, 6285 feet, noon. Hence, as regards this phase of the oscillation, and the steady diminution with height of the afternoon minimum, the influence of an isolated mountain like Mount Washington brings about a result quite similar to what is observed in insular situations. But the analogy of the curves of the two situations is closer still, the morning minimum in both being very strongly pronounced. Similarly in summer on the top of Ben Nevis, the morning maximum is retarded to 3 P.M., being seven hours later than the time of occurrence of the same phase at the base of the mountain; and the morning minimum is very large, whilst the afternoon minimum all but vanishes (Table IV. p. 27).

The differences offered by the daily curve of pressure at the top as compared with that at the base of a mountain are the simple results of the diurnal march of temperature. As the temperature of the air is lowest in the early morning, and the atmosphere therefore more condensed in the stratum between the top and base of the mountain, a portion of the atmosphere necessarily sinks bodily below the level of the top, thus lessening the whole pressure there. On the other hand, as temperature rises during the day with the returning sun, the stratum of air above the base of the mountain expands, thus raising more of the atmosphere above the barometer at the top, so that while at the base of the mountain pressure begins to fall about 9 A.M., on the top it continues to rise at the Ben Nevis Observatory till about 3 P.M., simply from the mechanical upheaval of the air owing to its higher temperature. This feature of the curve of pressure at the top of a mountain is thus essentially and immediately a temperature effect, resulting from the diurnal contraction and expansion with the changes of temperature of the aerial stratum between the top and bottom of the mountain.

The above curves of diurnal pressure have all been selected, it will be observed, from places situated in comparatively high latitudes, where the departures of the maxima and minima from the mean pressure are small; the object in selecting curves of small daily range being to present in as striking prominence as may be done the modifications impressed on the diurnal barometric fluctuations by mere height and by large tracts of land and sheets of water in respect of the extremely different conditions of surface temperature they offer at different hours of the day.

The following selection from places in comparatively low latitudes are intended to represent the effect of land and sea, and of dry and moist climates respectively, on the phenomena of the diurnal range of pressure. The differences from the means are given in thousandths of an inch.

	Jacobabad.	Ahmednugger.	Aden.		Bombay.		Dodabetta.	Havana.		Hong Kong.		Zi-ki-wei.		Ascension.	St. Helena.	Challenger Observations.				
Lat.	28° 19′	19° 6′	12° 46′		18° 54′		11° 32′	23° 8′		22° 18′		31° 12′		−7° 55′	−15° 55′	2° 50′	4° 8′	−1° 10′	−30° 59′	28° 8′
Long.	68 24	74 16	45 5		72 49		76 50	−82 23		114 10		121 20		−14 25	−5 43	−21 9	124 46	−150 46	−25 40	138 25
Month.	Feb.	April.	Jan.	Aug.	Jan.	July.	May–July.	Jan.	June.	Jan.	June.	Jan.	June.	Year.	Year.	Aug. 16–31	Oct. 11–31	Sept. 1–12	Oct. 1–14	April.
1 A.M.	—	—	*17*	*25*	*7*	*10*	*12*	7	5	8	3	*1*	*2*	1	*4*	—	—	—	—	—
2 ,,	—	—	*39*	*25*	*18*	*23*	*24*	*0*	*6*	*1*	*7*	*6*	*10*	*11*	*16*	*8*	*10*	*9*	*14*	*12*
3 ,,	—	—	*45*	*23*	*28*	*30*	*41*	*7*	*12*	*10*	*13*	*13*	*14*	*17*	*26*	—	—	—	—	—
4 ,,	—	—	*36*	*7*	*28*	*30*	*35*	*8*	*19*	*15*	*14*	*18*	*13*	*16*	*26*	*24*	*22*	*21*	*26*	*23*
5 ,,	—	—	*21*	9	*19*	*23*	*25*	*7*	*15*	*14*	*11*	*17*	*6*	*9*	*21*	—	—	—	—	—
6 ,,	—	40	*7*	31	*3*	*7*	*18*	4	*7*	*3*	2	*6*	5	2	*7*	*7*	*2*	4	*8*	8
7 ,,	70	50	18	50	21	9	*1*	14	4	13	13	8	15	13	8	—	—	—	—	—
8 ,,	87	77	34	67	48	23	19	29	9	34	23	27	21	25	23	22	32	29	13	17
9 ,,	97	74	44	90	68	33	31	37	14	51	30	37	22	32	34	—	—	—	—	—
10 ,,	85	57	42	90	68	37	44	39	21	55	32	43	22	30	36	32	45	33	29	30
11 ,,	50	44	18	67	50	32	36	26	14	42	27	29	19	22	29	—	—	—	—	—
Noon.	8	25	*12*	14	19	21	30	3	8	16	18	4	12	8	15	17	12	7	9	12
1 P.M.	*32*	*4*	*14*	*6*	*13*	7	15	*20*	2	*19*	2	*20*	*0*	*10*	*1*	—	—	—	—	—
2 ,,	*64*	*43*	*26*	*31*	*38*	*6*	4	*33*	*7*	*39*	*13*	*30*	*9*	*26*	*15*	*10*	*33*	*44*	*6*	*9*
3 ,,	*86*	*60*	*41*	*57*	*50*	*20*	*8*	*43*	*15*	*51*	*26*	*34*	*17*	*36*	*27*	—	—	—	—	—
4 ,,	*90*	*79*	*38*	*63*	*51*	*30*	*29*	*41*	*25*	*50*	*37*	*23*	*25*	*38*	*30*	*33*	*48*	*56*	*16*	*23*
5 ,,	*76*	*80*	*20*	*73*	*45*	*30*	*32*	*36*	*27*	*41*	*39*	*19*	*29*	*32*	*27*	—	—	—	—	—
6 ,,	*61*	*61*	2	*60*	*31*	*20*	*24*	*26*	*17*	*29*	*32*	*8*	*25*	*27*	*18*	*18*	*28*	*29*	*10*	*11*
7 ,,	*24*	*45*	14	*39*	*11*	*6*	*6*	*13*	*7*	*15*	*21*	4	*12*	*6*	*7*	—	—	—	—	—
8 ,,	2	*14*	25	*14*	6	7	4	3	3	4	*4*	11	1	9	7	1	4	3	8	*4*
9 ,,	29	0	24	15	20	18	26	14	15	13	8	14	12	20	18	—	—	—	—	—
10 ,,	—	—	22	11	22	24	31	19	22	18	22	14	19	27	24	20	30	18	12	9
11 ,,	—	—	10	*5*	14	19	25	23	27	20	22	8	12	25	20	—	—	—	—	—
Midt.	—	—	*3*	*11*	4	6	4	16	15	17	12	2	8	15	10	13	19	11	9	8

A selection from the hourly barometric oscillations of the Challenger is included in the table, from which it is seen that on small islands, such as Ascension and St. Helena, and, during the rainy season, of such localities as Havana, Bombay, Hong Kong, and Zi-ki-wei, the amounts and times of occurrence of the maxima and minima closely agree with what were observed on board the Challenger over the open sea in like latitudes.

The influence of the land, in dry climates, in increasing the amount of the oscillation is most strikingly shown at Jacobabad, where pressure rises at 9 A.M. to 0·097 inch above the mean, and at 4 P.M. falls to 0·090 inch below it, thus showing the large range of nearly two-tenths of an inch. At Aden, where the climate is dry at all seasons, the fall from the morning maximum to the afternoon minimum is 0·084 inch in January, whereas in August it amounts to 0·163 inch, or nearly double that of January, when the sun occupies a lower place in the sky. On the other hand, at Bombay, during the dry season in January, the range is 0·119 inch, but during the wet season in July, though the sun's position is then nearly vertical, the range is only 0·067 inch. The same peculiarity is seen in the corresponding seasons of Havana, Hong Kong, and Zi-ki-wei. At Dodabetta, 8640 feet high, the relatively lower morning minimum and retardation of the morning maximum, which characterise the curves of High Level Stations in the higher latitudes, are well illustrated.

Among the most valuable of the physical results arrived at from the observations made on board the Challenger—valuable from the important conclusions to which it leads—is the fact that the diurnal range of the mean surface temperature of the sea does not anywhere exceed a degree Fahrenheit, whilst the diurnal oscillations of the barometer occur over the open sea as well as over the land surfaces of the globe. It follows, therefore, that the atmosphere over the open sea rests on a floor or surface, subject to a diurnal range of temperature so small as to render the temperature practically constant both day and night.

This consideration leads at once to the all-important conclusion that the diurnal oscillations of the barometer are not caused by the heating and cooling of the earth's surface by solar and terrestrial radiation, and by the effects which follow these diurnal changes in the temperature of the surface, but that they are primarily caused by the direct heating by solar radiation and cooling by nocturnal radiation to the cold regions of space, of the molecules of the air and of its aqueous vapour, these changes of temperature being instantaneously communicated through the whole mass of the atmosphere from its lowermost stratum resting on the surface to the extreme limit of the atmosphere. There are, as has been shown, important modifications, affecting the amplitude and times of occurrence of the four principal phases of the phenomena, observed over land surfaces, the temperature of which is superheated during the day and cooled during the night, as observed in climates widely different as regards the

amount of aqueous vapour present in the atmosphere; but it is here particularly insisted on that the barometric oscillations themselves are independent of any changes of temperature of the floor on which the atmosphere rests. We shall, then, consider the phenomena chiefly, as the results of observation present them to us, as existing over the free ocean, and therefore cleared of all complications arising from the diurnal heating of the surface.

Physicists are divided in opinion as to whether the aqueous vapour of the air, while in the purely gaseous state, is or is not as diathermanous as is the dry air of the atmosphere, no decisive experiment having yet been made to prove the relation of purely gaseous vapour to radiant heat. But it is quite different as regards the water suspended in the atmosphere in the liquid, and in the solid form in minutely divided states, and as regards the particles of dust which recent research has shown to be everywhere present in the atmosphere. It is from Mr. John Aitken's ingenious experiments and researches that an insight may be obtained as to the relations of the dust particles to the aqueous vapour of the atmosphere.

Mr. Aitken showed, in his paper on Dust, Fogs, and Clouds,[1] that a solid nucleus is necessary for the condensation of water-vapour in the formation of fogs and clouds, and in subsequent communications to the Royal Society of Edinburgh he has shown that even the purest air that can be obtained contains an enormous number of fine dust particles. The purest air examined, which was obtained at Ben Nevis Observatory, contained 2100 dust particles per cubic inch; in Edinburgh, on a fine clear day, the number was 738,000; whilst in air taken from near the ceiling of a hall about the close of a meeting, the dust particles to the cubic inch were 57,400,000.

Let us now look at the phenomena of the diurnal oscillation as found in the Pacific near the equator, and in the midst of the largest water surface of the globe. Plate I. fig. 7 shows the hourly variations of pressure from observations by the Challenger, September 1 to 12, 1875, in mean lat. 1° 10′ S. and long. 150° 4′ W., the mean pressure for these days having been 29·928 inches. The most remarkable feature of the curve is the amplitude of the range from the morning maximum to the afternoon minimum, and the rapidity of the fall in the four hours from 10 A.M. to 2 P.M., amounting to 0·087 inch. This and the other features of the curve are substantially the same for all positions on the open sea for at least 12° on each side of the equator. In higher latitudes, over land, in anticyclonic regions, and in particular geographical situations, the curves become more or less modified. They all agree in showing the double maxima and minima, except in a few restricted regions of high latitudes already referred to.

If the temperature of the whole of the earth's atmosphere were raised, atmospheric pressure would be diminished, inasmuch as the mass of the earth's atmosphere would thereby be removed to a greater distance from the earth's centre of gravity. But quite

[1] *Trans. Roy. Soc. Edin.*, vol. xxx. pp. 337–368.

different results would follow if the temperature of only a section of the atmosphere were suddenly raised, such as the section, resembling the "lith" or division of an orange, comprised between 150° and 180° west longitude. The immediate effect would be an increase of barometric pressure from the expansion due to the higher temperature, and a subsequent effect would be the setting in of an ascending current, more or less powerful in proportion to the differences between the temperature of the heated section and that of the air on each side. These are essentially the conditions under which the morning maximum and the afternoon minimum take place.

The earth makes a complete revolution round its axis in twenty-four hours, and in the same brief interval the double-crested and double-troughed atmospheric diurnal tide makes a complete circuit of the globe. The whole of the diurnal phenomenon of the atmospheric tides is therefore rapidly propagated over the surface of the earth from east to west, and, as the movement of the surface is necessarily most rapid in equatorial regions, the amplitude of the oscillations there is greater than in higher latitudes under similar astronomical, geographical, and atmospherical conditions.

The Morning Minimum.—This depression of the barometric curve occurs from a little before midnight to near sunrise, or during the time when the effects of nocturnal radiation in lowering the temperature are the greatest. Pressure falls to the minimum about four in the morning.

Assuming that aqueous vapour in its purely gaseous state is as diathermanous as the dry air of the atmosphere, let us consider the part played by the dust particles suspended in the air. As nocturnal radiation proceeds, the temperature of each dust particle continues to fall below that of the air immediately surrounding it. From this state of things two important consequences follow—1st, the temperature of the whole atmosphere falls, and 2nd, as soon as the temperature of the dust particle reaches, in its cooling, the dew point of the air in contact with it, dew begins to be deposited on it, and the vitally important result follows that a portion of the aqueous vapour of the atmosphere passes from the gaseous to the liquid state, thus reducing the tension. Hence the morning minimum is due to a reduction of tension brought about by a comparatively sudden lowering of the temperature of the air itself and by a change of a portion of the aqueous vapour from the gaseous to the liquid state. Since this takes place at a more rapid rate than is compensated for by any mechanical or tidal movement of the atmosphere from the regions adjoining, owing to the inertia and viscosity of the air, pressure continues to fall to the morning minimum, which occurs some time before sunrise, or rather before dawn. It is probable that the commencement of the increase from the minimum before the air is yet heated by the indirect or direct rays of the returning sun is due to the setting in of a mechanical or tidal movement of the contiguous air towards this region where the pressure has been lowered. The morning minimum is thus due, not to any removal of the mass of air overhead, but to a reduc-

tion of the tension by a lowering of the temperature and change of state of a part of the aqueous vapour.

The Morning Maximum.—The diurnal heating of the atmosphere proceeds with the ascent of the sun. As the water condensed on the surfaces of the dust particles is evaporated, tension is increased by the simple change from the fluid to the gaseous state; and as the dust particles in the sun's rays rise in temperature above that of the films of air in contact with them, the temperature of the atmosphere is thereby raised, thus further increasing the tension. Under these conditions the barometer steadily rises with the increasing tension to the morning maximum. It is to be particularly noted that this rise of the barometer is not due to any accessions to the mass of air overhead, but only to increasing temperature and change of part of the watery vapour from the liquid to the gaseous state. Owing to the rapidity of the heating and increase of tension of the atmosphere through its whole height by the sun's rays, but more particularly in the lowermost strata where the dust particles are more numerous and, as the colours of sunset suggest, grosser than prevail in the upper regions of the atmosphere, some time must elapse before the greater expansive force thus called into play is able to counteract the vertical and lateral resistance it meets from the inertia and viscosity of the air. The only effect of the conversion of latent to sensible heat in these condensations, and the converse after sunrise, is but a slight retardation of the phenomena.

The Afternoon Minimum.—When this resistance has been overcome, an ascending current of the warm air sets in, and pressure gradually falls, as the mass of air overhead is reduced by the ascending current flowing back as an upper current to eastward, in other words, over the section of the atmosphere immediately to eastward, the temperature of which has now fallen considerably lower than that of the region from which the ascending current rises.

The Evening Maximum.—When the daily maximum temperature is past and temperature has begun to fall, the air becomes gradually more condensed in the lower strata, and, as a consequence, pressure at great heights is lowered, and, be it particularly noted, lowered most as compared with the pressure at the same height over the region from which the ascending current is rising. Hence it follows that owing to this relative difference of pressure, the ascending current, which rises from the longitudes where at the time the afternoon pressure is at the minimum, flows back to eastward, thus increasing the pressure over those longitudes where temperature has now greatly fallen. This atmospheric quasi-tidal movement occasions the evening maximum of pressure, which occurs from 9 P.M. to midnight, according to latitude and geographical position. As midnight and the early hours of morning advance, these contributions through the upper currents become less and less, and finally cease altogether, and the effects of the nocturnal radiation now going forward again introduce the morning minimum, as already described. Thus the afternoon minimum is occasioned by the removal of part of the mass of the atmosphere by the ascending current and its connected upper current,

and the evening maximum by accessions to the mass of atmosphere overhead from this upper current.

The Challenger observations all show that over the ocean, latitude for latitude, the amplitude of the oscillations is larger in an atmosphere highly charged with aqueous vapour, and less in a dry atmosphere. Also over the open sea, the morning minimum is largest in equatorial regions, and it diminishes with latitude; but its rate of diminution with latitude through anticyclonic and other regions is generally less and more uniform than is the case with the afternoon minimum.

From October 12 to 22, 1875, the mean pressure in lat. 35° 1′ S. and long. 134° 35′ W. was 30·298 inches, and the difference between the morning maximum and the afternoon minimum was only 0·036 inch; again, from July 12 to 19 in the same year, in lat. 36° 16′ N. and long. 156° 11′ W., the mean pressure was 30·328 inches, and the difference between the A.M. maximum and the P.M. minimum was only 0·025 inch. Thus in the Pacific about lat. 35°–36° N. and S., with a mean pressure much greater than near the equator, the oscillation is much less, being in the North Pacific less than a third of what occurs near the equator. In the same latitudes in the middle of the South Atlantic the difference was observed to be 0·025 inch, and in the North Atlantic 0·014 inch. Now these are regions of the four great oceans which are overspread by permanent anticyclones, and characterised by calms, light and variable winds, and the central regions of which are as a matter of fact but little traversed by sailors, as is well shown on Baillie's Meteorological Charts of the Oceans. These regions are shown on the Isobaric maps, and it will be seen that the surface winds outflow in every direction from the high pressure areas of the anticyclones. Since, notwithstanding the outflow of the surface, pressure remains high, it necessarily follows that the high pressure is kept up by an inflow of upper currents. As the slow descending air of the centre of the anticyclones connects the inflowing upper currents with the outflowing winds of the surface, it follows that the air filling the central areas of the anticyclones is relatively very dry,—every stage of its descent adding to its relative dryness,—and contains in all probability fewer dust particles than elsewhere. Hence over anticyclonic areas the atmosphere will be less cooled by nocturnal radiation and less heated by solar radiation, and the change of the aqueous vapour from the gaseous to the liquid state and *vice versa* will be also less than elsewhere. It follows that the amplitudes of the oscillation will diminish as the ocean becomes more land-locked with continents, in other words, as the anticyclonic region becomes better defined and currents of air, which rise from the heated surfaces of the adjoining continents, are poured down more steadily and copiously by the upper currents of the atmosphere. Hence of the four oceans, the smallest oscillation, 0·014 inch, is shown in the anticyclonic region of the North Atlantic, and the largest, 0·036 inch, in that of the South Pacific.

The geographical distribution of this oscillation is given in the accompanying Fig. 2, which shows for July its amount by lines of 10, 20, 40, 60, 80, and 100 thousandths of

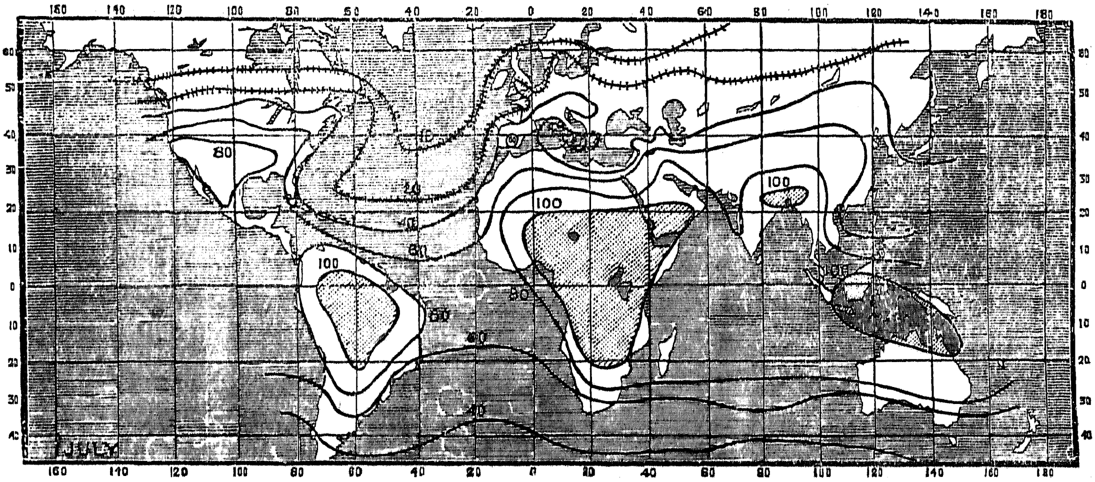


Fig. 2.—Chart showing the mean monthly amount of the diurnal oscillation of the barometer over the globe for July.

an inch, or 0·010 inch, 0·020 inch, etc. The abnormally small amount over the centre of the Atlantic and the Mediterranean begins in March, attains the maximum in June, and ends in October. It is thus confined to the warmer months of the year, and is not cumulative, like most other meteorological phenomena, but follows the sun, having its maximum in June. The smallness of the oscillation over the North Atlantic, which is probably less than occurs in any other ocean in the same latitude, is to a large extent caused by the small dip in the diurnal curve of the afternoon minimum, thus indicating an atmosphere where the heating by the sun is comparatively small. Over the open sea of the higher latitudes, the afternoon dip, or afternoon minimum, disappears, thus reducing the barometric curve to one maximum and one minimum during the twenty-four hours.

The much greater amplitude of the oscillations on land, as compared with the open sea, is entirely due to the heating of the surface of the earth, this higher temperature, which has its origin in the superheated surface, being in addition to the direct heating of the air by the heat rays of the sun as they pass through it. Tension is thereby still further increased, and, consequently, the morning maximum and the afternoon minimum are both more extreme than over the open sea. The oscillation reaches its maximum just in those tropical climates where insolation is strongest, and the effect is doubtless still further heightened by the greater number of dust particles present in the atmosphere of these climates.

In low latitudes, where the velocity of the surface due to the earth's rotation is near the maximum, the four phases of the barometric oscillations are most sharply defined and of greatest amplitude. But in the higher latitudes, where the velocity of the surface is much reduced, the amount of the oscillation is also small, and the one phase passes into the other by easy gradations.

It has been shown in the Table, p. 13, that in situations more or less insular

situated to westward of a pretty extensive tract of land, the forenoon maximum is retarded,—in some places as much as seven hours,—and that in all these cases the afternoon minimum is small and in some instances all but disappears. On the other hand, at no great distance from the coast, both inland and seaward, the afternoon minimum is quite distinctly seen, the retardation of the forenoon maximum rapidly gives way, and the chief phases of the diurnal oscillation occur near the normal times. This disturbance in the diurnal oscillation can scarcely be said to occur on the east coasts of tracts of land.

This peculiarity of the diurnal barometric tide is due to the circumstance that the air over the land is earlier and more rapidly heated than the air over the sea to westward of it, and, consequently, the ascending current sets in sooner and stronger over the land than over the sea, accompanied with the necessary result of the propagation of a temporary overflow to westward by a sub-upper current from the continental toward the insular situation. The retardation of the phases of the curve is also seen in lower latitudes, though less easily detected owing to the larger amounts of the oscillations. In summer, at Coimbra, pressure falls to the mean of the day shortly after noon, but at Lisbon it is an hour and at San Fernando an hour and a half later. At Milan it occurs about 12.45 P.M., but at Naples it is delayed to about 3 P.M.

The following Table presents another set of diurnal barometric curves totally different from any yet referred to. It gives in thousandths of an inch, the winter, summer, and annual means for Gries, Klagenfurt, and Cordova, to which Mexico is added.

	Gries, Lat. 46° 30′, Long. 11° 20′; Height, 958 Feet.			Klagenfurt, Lat. 46° 37′, Long. 14° 18′; Height, 1437 Feet.			Cordova, Lat. −31° 24′, Long. −64° 6′; 1460 Feet.			Mexico, Lat. 19° 26′, Long. −99° 0′; 7490 Feet.		
	Nov., Dec., Jan.	May, June, July.	Year.	Nov., Dec., Jan.	May, June, July.	Year.	May, June, July.	Nov., Dec., Jan.	Year.	Nov., Dec., Jan.	May, June, July.	Year.
1 A.M.	8	25	18	11	15	14	24	24	26	10	10	10
2 ,,	7	25	18	9	16	13	23	23	25	3	1	2
3 ,,	7	24	17	9	16	13	21	21	23	1	*2*	*2*
4 ,,	3	28	16	9	18	13	19	21	22	2	*0*	*0*
5 ,,	1	34	18	9	22	14	18	24	22	7	7	7
6 ,,	1	40	22	10	25	11	17	30	24	19	18	19
7 ,,	5	40	26	13	24	20	18	36	28	32	29	31
8 ,,	14	35	30	16	26	21	20	41	31	47	35	41
9 ,,	19	28	29	14	19	19	23	40	33	56	37	47
10 ,,	19	15	21	12	15	15	25	34	30	49	30	41
11 ,,	15	2	11	4	5	6	14	25	20	30	18	26
Noon	0	*15*	*6*	*6*	*5*	*4*	*4*	15	5	1	3	4
1 P.M.	*14*	*35*	*23*	*18*	*18*	*16*	*24*	*2*	*14*	*27*	*23*	*23*
2 ,,	*25*	*45*	*37*	*24*	*29*	*27*	*41*	*14*	*32*	*51*	*34*	*43*
3 ,,	*28*	*54*	*45*	*27*	*36*	*32*	*47*	*40*	*47*	*63*	*52*	*57*
4 ,,	*26*	*58*	*48*	*25*	*41*	*35*	*46*	*56*	*54*	*63*	*58*	*62*
5 ,,	*22*	*57*	*46*	*20*	*42*	*33*	*40*	*61*	*53*	*54*	*54*	*57*
6 ,,	*12*	*47*	*36*	*13*	*36*	*27*	*32*	*60*	*48*	*44*	*39*	*43*
7 ,,	*6*	*35*	*24*	*8*	*27*	*18*	*22*	*55*	*40*	*19*	*22*	*24*
8 ,,	1	*14*	*9*	*1*	*14*	*7*	*11*	*45*	*28*	*3*	*2*	*2*
9 ,,	4	4	3	5	3	4	*1*	*26*	*14*	16	13	16
10 ,,	9	14	11	7	8	8	10	*6*	2	21	25	24
11 ,,	10	21	15	8	12	10	20	13	17	19	28	24
Midnight	11	25	19	8	16	13	23	22	23	16	21	19

The most noticeable feature of these daily barometric oscillations is their very large amounts, those at Gries, though in lat. 46° 30′ N., being tropical in amount; and the singular circumstance is that in no season does the morning minimum fall so low as the daily mean. Gries, Klagenfurt, and Cordova are each situated in a deep valley, and they present the diurnal barometric curves characteristic of these places (Plate I. fig. 20). In such situations, during night, the whole surface of the region is cooled by radiation below the air above it, and the air in immediate contact with the ground becoming also cooled, a system of descending air-currents sets in over the whole face of the country bounding the deep valley. The direction and velocity of these descending currents are modified by the irregularities of the ground, and, like currents of water, they converge in the bottom of the valleys, which they fill to a considerable height with the cold air they bring down from the sides of the mountains. This cold and consequently relatively dense air rises above the barometers which happen to be down in the valley, with the result that a high mean pressure is maintained during the night. In summer the pressure at the coldest time of the night is maintained, 0·020 inch, at Klagenfurt, higher than it is in open situations in that country, and double this amount, or 0·040 inch, at Gries. On the other hand, during the day these deep valleys become highly heated by the sun, and a strong ascending current is early formed, under which pressure falls unusually low. Thus, while at Vienna the afternoon minimum falls 0·026 inch below the daily mean, at Klagenfurt the amount is 0·042 inch, and at Gries 0·058 inch.

The same feature of the pressure is seen, though in a much less pronounced degree, in the curves for Mexico, where the daily range is usually large for so elevated a station and consequent low mean pressure, and where the morning minimum either does not fall to the mean of the day or but little below it.

On the other hand, at high-level observatories, such as Obirgipfel and Ben Nevis, which are situated on true peaks, the daily curve of pressure is wholly different (Plate I. fig. 21). In these situations the curves all show an abnormally large morning minimum, and, in summer more particularly, an afternoon minimum so small as all but wholly to disappear.

It follows that the diurnal curves of atmospheric pressure are liable to large modifications according as the earth's surface, in the more immediate neighbourhood of the barometer from which the observations are made, presents a level plain, a troughed hollow between mountains or rising grounds, or an isolated peak.

In high latitudes, in the interior of continents, when there is either constant sunshine, or sunshine and a strongly pronounced twilight, the morning minimum is much reduced, and in the height of summer vanishes altogether, being probably the effect of the short nights, the comparatively slow motion from the earth's rotation, and the constant heating from the sun's rays, direct or indirect. The summer curve for

Fort Rae, lat. 62° 39′ N., long. 115° 44′ W., illustrates this peculiarity of the diurnal pressure (Plate I. fig. 15).

Over the ocean in high latitudes the diurnal curves of pressure show only one maximum and one minimum, but the times of their occurrence are directly opposite to those over land.

It is evident that in employing the data of Table IV. in "correcting" for daily range, with the view of bringing the observations to the true daily mean pressure, the greatest care is required in selecting stations whose means will give approximately true "corrections." Indeed, as regards narrow steep valleys, any such attempted reductions can at best only be regarded as useless.

The daily oscillations of pressure at places given in Table IV. show the same feature to be apparent even in comparatively shallow valleys bounded by distant rising grounds with low surface gradients. This consideration must not be lost sight of in any effort to trace the simple temperature effect on the daily barometric tides. In truth, the observed temperatures made at the station can be used in such a discussion only when the observations are made on the open sea, or on what is substantially an open plain at some distance from the sea. On coasts, in comparatively narrow valleys, but in a less degree on peaks, the problem becomes very complicated, and in attempting to solve it the temperature of the region for some distance round the place of observation must also be taken into account.

Towards the end of Table IV. are given the diurnal ranges for Polar Stations, including nearly the whole of the International Arctic and Antarctic Stations during 1882 and 1883. An examination of these is sufficient to show that several results must be accepted with some reserve as a representation of the facts of the diurnal variation of pressure in these higher latitudes. More might have been made of these observations if they had been published as made, that is, if, instead of reducing to 32°, by the methods in common use, the original readings of the barometer and of the attached thermometer had been printed. Since the daily range in these regions is very small, probably not exceeding 0·010 inch, and since in every case when the temperature shown by the attached thermometer differs from that of the barometer taken as a whole, it follows that for every degree of difference the reduced observations contain an error of about 0·003 inch. Indeed, the hourly pressures at several Arctic Stations, instead of showing the horary changes of pressure, appear in some cases to indicate in an obscure way the changes of temperature, artificial or otherwise, of the apartment where the barometer was hung. In those cases where care has been taken to secure that the monthly means of the attached thermometers, for the different hours of the day, represent the temperature of the whole barometer to within a degree, the results show the extension of the oscillations into Arctic and Antarctic regions. They are probably dependent on the diurnal changes in the temperature of the air itself, irrespective of those of the earth's surface, and they may be, in some way, influenced by quasi-tidal movements from lower latitudes.

Variation of the Force of the Wind.—During the cruise of the Challenger, observations of the force of the wind were made on 1202 days, at least twelve times daily, 650 of the days being on the open sea, and 552 near land. The observations were on Beaufort's scale 0–12, being the scale of wind force observed at sea. The results showing the hourly variations in the force of the wind are given in the following table, where the observations have been grouped according to the five oceans in which they were made, viz.: the North Atlantic, the South Atlantic, the North Pacific, the South Pacific, and the Southern Ocean:—

	N. Atlantic.		S. Atlantic.		N. Pacific.		S. Pacific.		Southern Ocean.		Mean.	
	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.
No. of Obs. .	192	91	87	75	142	165	156	168	73	53	650	552
2 A.M. . .	2·96	2·27	3·10	2·26	2·59	1·31	2·67	1·34	4·40	2·26	2·98	1·72
4 " . . .	3·00	2·30	3·14	2·03	2·34	1·20	2·65	1·39	4·07	2·28	2·90	1·67
6 " . . .	2·95	2·23	3·05	2·14	2·22	1·14	2·62	1·27	4·04	2·60	2·85	1·66
8 " . . .	2·94	2·23	2·90	2·12	2·28	1·09	2·71	1·37	3·82	2·93	2·83	1·69
10 " . . .	3·12	2·55	3·01	2·40	2·21	1·27	2·68	1·76	3·96	3·28	2·87	2·01
Noon . . .	3·08	2·55	2·97	2·57	2·34	1·65	2·78	2·14	4·03	3·52	2·92	2·27
2 P.M. . .	3·07	2·82	3·06	2·68	2·37	1·67	2·59	2·18	4·20	3·57	2·92	2·36
4 " . . .	2·97	2·74	3·13	2·61	2·27	1·71	2·58	2·08	4·26	3·49	2·87	2·30
6 " . . .	2·95	2·48	3·12	2·60	2·28	1·37	2·64	1·69	4·06	3·44	2·87	2·08
8 " . . .	2·94	2·27	3·21	2·34	2·26	1·13	2·66	1·35	4·00	2·87	2·85	1·76
10 " . . .	3·01	2·17	3·25	2·27	2·39	1·15	2·60	1·37	4·16	2·40	2·92	1·68
Midnight . .	2·96	2·23	3·16	2·18	2·27	1·32	2·61	1·43	4·16	2·40	2·87	1·75
Means . . .	3·00	2·40	3·09	2·35	2·32	1·33	2·65	1·61	4·10	2·92	2·89	1·91
Means (miles)	18	15	18½	15	15	10	16	11	23	13	17	13

Thus the velocity of the wind is greater over the open sea than on or near land, the mean difference being from four to five miles per hour. Of the five oceans, the velocity is greatest over the Southern Ocean, and least over the North Pacific, the difference being eight miles per hour. In the part of the cruise embracing the Southern Ocean, the Challenger crossed and re-crossed the "roaring forties," and hence probably the higher observed velocity of the wind over this ocean.

With respect to the open sea, it is evident from the mean curve for the five oceans (Plate II. fig. 22) that the diurnal variation is very small, there being apparently two indistinctly marked maxima about midday and midnight respectively. But on examining the separate means of each of the five oceans, there appears to be no uniform agreement observable among their curves, the slight variations being different in each case. Looking at the curves in connection with the number of observations from which each has been drawn, it seems probable that the line representing the true diurnal variation in the velocity of the wind is practically a uniform straight line, with the single exception of a small rise about midday, not quite amounting to a mile per hour.

mean, and the influence of the higher temperature is, in some degree, to counteract the retardation of the wind's velocity resulting from friction and from the viscosity of the air encountered near land.

An explanation not unfrequently adduced is that the variation is due to the ascending currents with their reduced velocities, and the descending currents with their increased velocities, which set in as the necessary result of the unequal heating of the surface at different hours of the day. Now if this were so, the increased velocity during the hottest hours of the day would be closely congruent with the diurnal curve of atmospheric pressure, commencing with the time when pressure begins to fall from the morning maximum, in other words, from the time the ascending current sets in, and would reach the maximum at the hour of the afternoon minimum of pressure, that is, the time when the ascensional current is strongest. Observation does not bear this out, since the increase in the diurnal velocity sets in before pressure begins to fall from the morning maximum; and the maximum, in the summer months when the whole phenomena are most pronounced, occurs from two to four hours before the time of the afternoon minimum of pressure. The time of occurrence of the maximum velocity is from 1 to 2 P.M., or when the diurnal insolation is strongest. Observations thus point to the conclusion that, while ascensional and descensional currents play a part in bringing about the diurnal variation, by far the more important part is due to the difference between the temperature of the earth's surface and that of the wind blowing over it at the moment. It is evident that when the surface of the ground is superheated, and an ascensional movement of the air has set in from the heated surface, the retardation of the wind's velocity, resulting from friction and from the viscosity of the air, is more or less counteracted, and the velocity of the wind is thereby increased. On the other hand, during the night, when terrestrial radiation is proceeding, the temperature of the surface rapidly falls, all ascensional movement ceases and gives way to a descensional movement of the lowermost stratum of the air down the slopes of the country, with the result that during these hours the retardation of the wind's velocity from friction is greatest.

Variation in the Amount of Cloud.—The diurnal variation in the amount of cloud in the sky over the open sea is very small. The following are the means of 277 days' observations on board the Challenger, stated in percentages of sky covered with clouds:—

2 A.M.,	59	2 P.M.,	58
4 ,,	59	4 ,,	59
6 ,,	62	6 ,,	57
8 ,,	62	8 ,,	57
10 ,,	58	10 ,,	57
Noon,	56	Midnight,	57

Two maxima are here indicated, the one about or shortly after sunrise, and the other in the early part of the afternoon; and two minima, the one at noon and the other from sunset to midnight. But the difference between the daily extremes is only 6 per cent. of the sky. The diurnal variations in the amount of cloud are among the less satisfactorily observed phenomena of meteorology. From what has been done, however, a few general deductions may be made. A maximum occurs in the morning and continues till a little after sunrise, and this maximum is more pronounced over the open sea than over land. Its appearance may be regarded as due to the general cooling of the atmosphere through its whole height by terrestrial radiation, and its disappearance by the heating of the air by the returning sun. The first of the two minima extends from this time to about noon, this relatively greater clearness of sky occurring thus while temperature is most rapidly increasing and before the ascending current has set in in any considerable volume. The period of this ascending current, or the time of the afternoon minimum of atmospheric pressure, marks the afternoon maximum of cloud, which over the land surfaces of the globe is much larger than the morning maximum, being thus the reverse of what the Challenger observations disclose.

Of this maximum the cumulus is the characteristic cloud. These are but the summits of the ascending currents that rise from the heated land, in which the aqueous vapour is condensed into cloud during the expansion and consequent cooling that takes place with increase of height. Cumulus clouds cast an instructive light on the behaviour of the ascending currents rising from the more highly-heated lowermost strata of the atmosphere, inasmuch as they indicate that the current ascending from the surface is broken up into subdivisions that are thereafter grouped into separate well-defined ascending currents, each of which is marked off and topped by the cumulus cloud. It is highly probable, considering the clearly-defined positions of these clouds, that the air composing the ascending currents is not only warmer but that it is also moister than the air in and beneath the clear interspaces; and, further, it may be regarded as probable that it is down through these clear interspaces that the descending air filaments shape their course in their way downwards to take the place of the air molecules that ascend from the heated surface of the earth.

The secondary minimum of cloud occurs from about sunset onwards during the time occupied by the evening maximum of atmospheric pressure. The frequent dissolving and final disappearance of cloud from about sunset onwards as the evening advances is familiar to all, occurring in those types of weather, principally, when the evening maximum of pressure for the day is most distinctly marked.

It is to be noted here that in a highly-saturated atmosphere, which is so characteristic a feature of many tropical climates at certain seasons, this time of the day is remarkable for the amount of cloud; and it is in those seasons, and during those hours, that heat-lightning, or lightning without thunder, attains its annual

maximum period, and also its diurnal maximum period, which is from six to eight hours later than that of thunderstorms.

Variation in the Amount of the Rainfall.—During the cruise every instance of precipitation,—rain specified as passing showers or continued rain, drizzle, sleet, or snow,—were recorded in their place of occurrence among the two-hourly observations. These have been tabulated and summed up, with the following result:—

	Rain.				Rain.		
	Over open Sea.	Near Land.	Total.		Over open Sea.	Near Land.	Total.
2 A.M.,	130	87	217	4 P.M.,	95	71	166
4 „	118	90	208	6 „	101	74	175
6 „	117	75	192	8 „	113	82	195
8 „	115	75	190	10 „	114	79	193
10 „	113	82	195	Midnight,	112	83	195
Noon,	110	79	189				
2 P.M.	103	75	178	Total,	1341	952	2293

These figures show (Plate II. fig. 24) that, as regards the occurrence of rain over the open sea during the day, there is one maximum of 130 instances at 2 A.M., and one minimum of 95 instances at 4 P.M.; and that, while for the twelve hours ending 8 A.M. the number of cases was 706, for the twelve hours ending 8 P.M. the number was 635. Hence the frequency of occurrence of rain over the open sea is simply inversely as the temperature. Near land the distribution of rain during the twenty-four hours is different, the results showing two maxima and two minima, the secondary maximum occurring from 10 A.M. to 2 P.M., the two maximum periods being the times of maximum and minimum temperature, and the two minima the early morning and early evening respectively.

Dr. Bergsma has shown, from sixteen years' observation made at Batavia, the diurnal variation at that place, of which the following are the percentages of the daily amount which fell every two hours:—

Midnight to 2 A.M.,	8·7	Noon to 2 P.M.,	9·5
2 A.M. „ 4 „	6·4	2 P.M. „ 4 „	12·2
4 „ „ 6 „	6·1	4 „ „ 6 „	13·5
6 „ „ 8 „	5·2	6 „ „ 8 „	10·5
8 „ „ 10 „	5·5	8 „ „ 10 „	7·4
10 „ „ noon,	6·3	10 „ „ midnight,	8·7

It will be observed that this curve is the reverse of the curve for the open sea,

while the curve for the observations made near land partakes of the character of both curves. Much yet requires to be done in collecting the suitable data of observation for a proper treatment of the question of the diurnal curves of the rainfall of different climates. Such data, however, so far as collected, show the general occurrence of a maximum from about 11 A.M. to 6 P.M., and this peculiarity of the curve is a particularly outstanding feature of the curves of continental climates during the summer months of the year, when thunderstorms have their maximum annual occurrence. A marked diminution of the rainfall is generally observed from about sunset to midnight, or during the hours when, in many climates, the amount of cloud falls to the minimum, and the evening maximum of pressure takes place. The time of the morning minimum of pressure, from about 2 to 6 A.M., is, curiously, in many places strongly marked as a maximum, whereas in others it is equally strongly marked as a minimum, of which the Challenger and Batavia curves may be taken as typical examples.

Variation of Thunderstorms. — The following table shows the distribution through the hours of the day of the cases of occurrence during the cruise—(1) of thunderstorms or thunder with lightning, and (2) of lightning alone :—

	Thunderstorms.			Lightning only.		Thunderstorms.			Lightning only.
	Open Sea.	Near Land.	Total.			Open Sea.	Near Land.	Total.	
Midnight to 2 A.M.	4	2	6	42	2 P.M. to 4 P.M.	2	2	4	2
2 A.M. ,, 4 ,,	7	2	9	36	4 ,, ,, 6 ,,	0	1	1	7
4 ,, ,, 6 ,,	5	0	5	11	6 ,, ,, 8 ,,	0	2	2	25
6 ,, ,, 8 ,,	8	2	5	0	8 ,, ,, 10 ,,	1	2	3	46
8 ,, ,, 10 ,,	1	2	3	0	10 ,, ,, midnight	3	3	6	89
10 ,, ,, noon	0	0	0	0					
Noon ,, 2 P.M.	0	1	1	1	Total	26	19	45	209

Of the 45 thunderstorms recorded, 26 occurred over the open sea, and 19 near land. Of those recorded over the open sea 22 occurred during the ten hours from 10 P.M. to 8 A.M., whereas during the other fourteen hours of the day only 4 occurred (Plate II. fig. 25). Hence the important conclusion that over the open sea thunderstorms are essentially phenomena of the night, and occur chiefly during the morning minimum of pressure. On the other hand, as regards the thunderstorms which occurred near land, they are pretty evenly distributed during the twenty-four hours.

Over land, but especially where the climate is more or less continental in its character, the distribution of thunderstorms during the day is the reverse of the above. The following table shows the number of (1) thunderstorms, and (2) lightning only,

recorded at Oxford during twenty-four years, for the seven months from April to October, of which months August is represented on Plate II. figs. 26 and 27 :—

	Thunderstorms.								Lightning only.							
	April.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Total.
Hour ending																
1 A.M.	1	2	6	3	2	0	0	14	0	2	1	3	4	2	0	12
2 „	2	1	1	1	1	0	1	7	0	0	0	0	3	2	0	5
3 „	1	2	3	2	1	0	2	11	0	0	0	0	0	1	0	1
4 „	0	1	4	3	0	1	1	10	0	0	0	0	0	0	0	0
5 „	0	3	3	2	2	1	1	12	0	0	0	0	0	0	0	0
6 „	0	2	3	6	1	3	1	16	0	0	0	0	0	0	2	2
7 „	1	1	2	2	0	1	0	7	0	0	0	0	0	2	1	3
8 „	0	1	2	3	0	1	0	7	0	2	1	0	0	4	1	8
9 „	0	1	2	4	1	1	0	9	0	0	2	0	0	3	5	10
10 „	0	1	4	2	1	1	0	9	0	0	1	4	1	3	1	10
11 „	0	2	3	2	1	0	0	8	0	0	0	1	0	1	1	3
Noon	3	7	6	3	4	1	0	24	0	0	0	0	0	1	1	2
1 P.M.	0	5	5	6	8	7	3	34	0	0	0	0	0	1	0	1
2 „	1	5	5	1	7	7	1	25	0	0	0	0	2	2	0	4
3 „	2	8	6	7	7	3	0	33	0	0	0	1	2	2	0	5
4 „	2	6	9	7	8	5	2	38	0	0	0	0	2	2	0	4
5 „	3	5	5	7	4	3	0	27	0	0	0	0	2	0	1	3
6 „	1	5	4	7	6	5	0	28	0	0	0	1	3	3	5	12
7 „	1	2	4	0	6	4	0	17	0	1	0	0	2	3	12	18
8 „	1	2	2	0	3	1	0	9	2	2	2	1	5	8	4	24
9 „	1	3	2	3	4	2	0	15	0	2	2	4	11	6	7	32
10 „	1	3	1	1	3	3	0	12	0	3	3	11	18	5	4	44
11 „	1	1	3	1	2	2	1	11	1	3	2	10	15	4	2	37
Midnight	1	2	4	4	2	2	0	15	1	2	4	9	12	4	1	33
Total	23	69	89	77	74	54	13	399	4	17	18	45	82	59	48	273

During the other five months of the year electrical displays are infrequent. As these figures for Oxford may be accepted as typical of the distribution of thunderstorms during the day, and the times of the maxima and minima over the land surfaces of the globe at some distance from the sea-coast, it is evident that the diurnal maximum occurs in the afternoon, and is substantially coincident with the afternoon minimum of atmospheric pressure; whilst on the other hand, the maximum over the open sea is closely coincident with the morning minimum of pressure. Over the land the maximum of thunderstorms occurs during the hours of the day when temperature is highest, but over the open sea during those hours when temperature is lowest. The great majority of thunderstorms over the land thus occur during the part of the day when the ascensional movement of the air from the heated surface of the ground takes place, and they reach the maximum when the temperature and this upward movement are also at the maximum. It thus appears that ascending currents and their necessary accompaniment, descending currents in the atmosphere, play an important part in the history of thunderstorms.

In places where the climate is dry and rainless, like that of Jerusalem in the

summer months, thunder is quite unknown; and places such as Coimbra and Lisbon, where the summer rainfall is small and its occurrence rare, thunderstorms become less frequent, and the hours of their occurrence become later than before and after the dry season. Further, when during a particular season an anticyclone, with its great descending current in the centre, remains over a region, as happens in the centre of the old Continent during winter, thunder is equally unknown.

In this connection much interest is attached to the thunderstorms of Mauritius, arising from its isolated position in a vast ocean, and its relations to the great movements of the atmosphere in that part of the globe. In this island there are two maxima in the diurnal curve, the larger of the two occurring from noon to 4 P.M., and the smaller from 3 to 6 A.M., these being the times of the two barometric minima, or the times of maximum occurrence from the Challenger observations over the open sea and inland at Oxford; and two times of minimum occurrence, from 9 P.M. to 1 A.M. and from 8 to 10 A.M., these being near the times of the barometric maxima. Another important fact, as regards the thunderstorms of Mauritius, is, that during twelve years none were recorded in June and July, one in August, one in September, and three in October. Observations show that the annual period of thunderstorms is the seven months from near the end of October to the middle of May, or during the time of the greatest rainfall, while practically none occur during the other five months. In these five months rain, however, continues to fall, amounting to an average of about two inches each month. Thus, during these months, there is in the atmosphere the aqueous vapour, and these being relatively dry months, there are also the conditions of ascending currents. There is, however, wanting another element essential to the electrical manifestations of the thunderstorms during the relatively dry season of Mauritius. Now during the months when thunderstorms are of no infrequent occurrence, the high atmospheric pressure of Asia repeatedly advances, as Dr. Meldrum has pointed out, southward towards Mauritius, so that frequently the belt of variable winds and calms, between the two trades, stretches in a slanting direction from Madagascar to Ceylon. While this distribution of pressure occurs with more or less frequency, the conditions of a descending cold current of large volume are provided, and thunderstorms are frequent; and it is under analogous conditions afforded by the cyclones and anticyclones of north-western Europe, that nearly all the winter thunderstorms in the west of Scotland occur. But from June to September there is an unbroken increase of pressure from Central Asia southwards to beyond Mauritius, thus placing it within this high pressure area and in the heart of the south-east trades, and while this continues the conditions favourable for the development of the thunderstorms are wanting.

It has been shown that over the open sea thunderstorms are essentially nocturnal phenomena. As regards thunderstorms over the land surfaces of the globe, the disturbance of atmospheric equilibrium, resulting in ascending and descending currents,

is brought about mainly by the super-heating of the surface and thence of the lowermost strata of the air. But as regards the open sea, this mode of disturbing the atmospheric equilibrium cannot take place, inasmuch as the influence of solar radiation is only to raise the temperature of the surface of the sea not more than a degree. Hence it is probable that the disturbance of the equilibrium of the atmosphere in the case of thunderstorms over the open sea, is brought about by the cooling of the higher strata of the atmosphere by terrestrial radiation.

An inspection of the curves of thunderstorms for Oxford, or of thunder with lightning, and of lightning without thunder (Pl. II. figs. 26 and 27), shows that they are quite different from each other,—the difference, and it is a vital one, being that while the curve for thunderstorms is coincident with the afternoon minimum, the curve for lightning only is coincident with the evening maximum of atmospheric pressure, or from five to six hours later. Part of this, but no more than an insignificant part, is due to those instances of heat-lightning which are but the reflection of distant flashes of lightning, the thunder accompanying which is not heard. By far the majority of the cases of heat-lightning are not connected with thunder, as is conclusively shown by the curve for August at Oxford, where the very pronounced maximum occurs during the two hours from 9 to 11 P.M., long after darkness has set in, and when the curve for thunderstorms has fallen from the daily maximum to near the minimum. I have calculated or otherwise collected the averages for the curves of these phenomena for nearly two hundred places in all climates of the world, and the result is to show that the two curves are essentially distinct and different from each other, showing conclusively that many electric discharges are not accompanied with thunder.

As explained, the diurnal maximum of heat lightning is coincident with the evening maximum of atmospheric pressure, that is, during those hours when the upper strata over the place are having poured over them a warmer and moister stratum of air which has its origin in the ascending current of the longitudes immediately to westward, where the afternoon minimum of pressure is then taking place. In this connection it is highly significant that while in May the number of cases of lightning was 17, in August, when the ascending current has much greater relative and absolute humidity, the number of cases was 82, or about five times greater than in May.

Over the open sea, the diurnal curve of lightning is closely coincident with the evening maximum of pressure, the maximum occurring about midnight (see Table, p. 31). The relations of the maximum of lightning to thunderstorms over the open sea is essentially different from what obtains over land. Thus, while over land the maximum of lightning occurs from five to six hours later than that of thunderstorms, over the ocean it occurs about four hours earlier. The order of occurrence of these phenomena in the summer months is this—thunderstorms over land, from 2 to 6 P.M.; lightning

over land, 8 P.M. to midnight; lightning over the open sea, 8 P.M. to 4 A.M.; and thunderstorms over the open sea, 10 P.M. to 8 A.M.

The evening maximum atmospheric pressure occurs at the time when the aurora attains its diurnal maximum. Thirty years' observations at Christiania Observatory give the number of times the aurora was observed each hour as under :—

Hour ending 4 P.M.	7 times.	Hour ending 1 A.M.	53 times.
„ 5 „	16 „	„ 2 „	42 „
„ 6 „	46 „	„ 3 „	21 „
„ 7 „	105 „	„ 4 „	10 „
„ 8 „	133 „	„ 5 „	11 „
„ 9 „	156 „	„ 6 „	1 „
„ 10 „	529 „	„ 7 „	0 „
„ 11 „	130 „	„ 8 „	1 „
„ Midnight	79 „	Total,	1320 times.

Of the 1320 instances recorded, it is seen that 529 occurred in the hour from 9 to 10 P.M., and in the four hours from 7 to 11 P.M. 948 cases were observed, a result probably dependent in no small degree on the atmospheric conditions resulting in the evening maximum of pressure, the more abundant ice spicules in the upper regions at the time serving as a screen for the better presentation of any magneto-electric discharges that may occur.

Monthly, Annual, and Recurring Phenomena.

Of the annual recurring phenomena of the atmosphere, the distribution of atmospheric pressure, atmospheric temperature, and the prevailing winds of the globe, during the months of the year have, as the more important, been thoroughly revised for this article. The data on which the revision is based are given in Tables V. to IX., and the results are graphically represented on Maps I. to LII., which show the monthly isothermals, isobars, and prevailing winds over the globe. These represent the average temperature, pressure, and direction of wind over the larger portion of the land surfaces of the globe based on the fifteen years' observations beginning with 1870 and ending with 1884.

Charts showing by *isobaric lines* the mean pressure of the atmosphere through the months of the year, may be considered as furnishing the key to the fundamental questions of meteorology, since it is only by the information thereby obtained that questions relating to the prevailing winds, and the varying temperature, cloud, and rainfall of different regions, can be satisfactorily handled.

Now, in an inquiry into the comparative mean distribution of atmospheric pressure, it is clear that the first, and indeed, as respects time, the essential requisite, is that the means be drawn from observations made in the same years. In tropical and most subtropical regions, where the mean pressure differs but little for the same month from year to year, that the observations be for the same years is not a matter of such paramount importance; but elsewhere, owing to the more or less marked instability which prevails with regard to pressure, it becomes of the utmost importance to obtain the means of observations for the same years.

Mean Pressure.—The mode in which the observations were discussed was first to extract, for each country by itself, the mean monthly pressures reduced to 32°, where these were obtainable, year by year. Since in this way the curve of variation from month to month was easily kept in mind, many typographical errors, faulty averages calculated from portions of months only, and other anomalies, were detected, and these doubtful means were at once inquired into and rectified.

As the work advanced, the mean annual pressure, further reduced to sea level, for each station for which observations for the whole of the fifteen years were available, was entered on maps of the countries. The results for every country showed anomalies and discordances in the barometric means, which called for inquiry with a view to their rectification approximately.

No inconsiderable number of errors were occasioned by incorrect heights. These have been rectified by correspondence; but in cases where no levelling or trigonometrical survey has been made, approximate heights have been adopted, deduced from the annual chart of mean pressure. Some errors were found to be due to the state of the barometer, or to its verticality. But the larger number of anomalies had their origin in the personal errors of the observers, arising mainly from the different methods employed in setting the vernier of their barometers. These may be classed as under: (1) setting the vernier in the line of that part of the top of the mercury which is in immediate contact with the glass tube, the instrument being thus read about 0·033 inch too low, more or less, according to the diameter of the tube; (2) setting the vernier by bringing it down till the speck of light on each side is on the point of disappearing, the error in this case being from 0·008 inch to 0·020 inch too low, according to the breadth of the slit; (3) setting the vernier so that a clear space is left between it and the tangent to the mercurial curve, the error in this case being about 0·010 inch too high. The last method of reading is mostly caused by weak or failing sight, the observer not being aware that a lens or spectacles is now required, and consequently it does not materially affect the observations, when two readings are made, as from a Fortin or siphon barometer. It leads, however, to the above error of about 0·010 inch with Board of Trade and other barometers, which take no account of the height of the mercury

in the lower limb of the instrument. This inquiry leaves little if any doubt that these personal errors, in one form or other, are more general than might have been supposed, and accordingly, particular attention was given, in extracting the monthly means, to all changes made as regards observers, with a view to ascertain their personal errors.

There was no real difficulty in ascertaining the errors of particular barometers in countries where stations are more or less numerous, and the meteorological system under a competent control, if the ordinary sources of error are kept in view. But over large portions of South America, Africa, and Oceania another method for the detection of errors was required. In these regions the barometers have been controlled by Baillie's Isobars for the ocean, recently published by the Meteorological Council. In this work the annual chart is the mean of the four months, February, May, August, and November. The mean pressure at 32° and sea level, for the four months, was calculated for the stations of these regions, and the result being entered in its place on the annual chart, the approximate error of the particular place was ascertained. It may be added that Baillie's Isobars may well serve as a control, seeing they are exclusively drawn from observations made only with properly compared barometers. In Table V., the corrections which have been adopted are in every case entered in the last column, from which, it need scarcely be added, the original uncorrected observations may, if desired, be found.

In the first place, the figures entered on the maps were restricted to those stations from which observations for each of the fifteen years were available. It may be said of no country that the number and distribution of its stations, furnishing observations for the whole of this period, are sufficient for the purpose on hand. Hence it was absolutely necessary in an inquiry where the same time must be dealt with, to cover the ground in a more adequate manner with the means of other stations at which observations have been made for other periods than the fifteen years, these means being deduced by applying corrections to the monthly means arrived at by differentiation with neighbouring stations.

In differentiating, the work was overtaken generally according to the length of the times covered by the period of the observations of the stations, the means of which were in the course of being rectified, beginning with the longest periods and ending with the shortest. In a good many cases the same period for differentiation was made to embrace a very wide area. Thus, over considerable portions of France, Germany, Italy, and North Africa, observations were available only for the seven years 1878 to 1884. The following table was accordingly prepared, showing for forty-three places the differences in thousandths of an inch of each month's average for these seven years, compared with the averages of the same months for the fifteen years, which may serve as an example of the method of differentiating employed:—

TABLE.—Showing, for Forty-three Places in Western and Southern Europe, the differences between the Monthly Barometric Means of the seven years 1878–84 and the fifteen years 1870–84. The minus sign indicates that the correction to be applied to the means of 1878–84, to bring them to the means of 1870–84, is subtractive, and no sign that it is additive.

N.B.—The differences or corrections are expressed in thousands of an inch.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Falmouth, . .	–111	8	–33	60	10	25	20	30	5	–50	–69	–34	...
Jersey, . .	–98	–4	–33	56	–1	24	14	16	3	–45	–70	–27	...
Brighton, . .	–97	–4	–31	45	8	24	25	44	7	–38	–51	–15	...
Flushing, . .	–86	–5	–36	55	0	34	25	24	5	–22	–38	–10	...
Utrecht, . .	–60	–14	–32	36	0	30	26	28	2	–24	–40	–8	...
Cologne, . .	–52	–8	–26	40	0	30	18	22	8	0	–50	–16	...
Göttingen, . .	–20	6	–32	38	–10	24	28	22	4	–10	–44	4	...
Bayreuth, . .	–36	–16	–20	40	–4	26	24	30	20	5	–34	4	...
Munich, . .	–40	–20	–24	44	–4	20	20	24	24	–6	–64	–20	...
Carlsruhe, . .	–54	–22	–23	46	3	24	16	26	8	–6	–44	–20	...
Luxemburg, .	–52	–32	–30	40	4	20	20	32	8	–20	–56	–24	...
Paris, . . .	–72	–16	–24	56	0	24	12	24	20	–24	–60	–28	...
Ste. Honorine-du-Fay, . .	–76	–16	–16	48	–4	22	10	20	4	–40	–58	–32	...
Lyons, . .	–52	–28	–24	52	–12	12	12	12	20	–18	–70	–38	...
Montpellier, .	–32	–28	–10	62	0	24	16	12	12	–16	–48	–32	...
Perpignan, . .	–48	–32	–26	24	–12	4	8	16	12	–12	–70	–48	...
St. Martin de Hinx, . .	–34	–6	–5	61	4	16	6	22	4	–6	–58	–40	...
Coimbra, . .	–24	–24	–6	34	–12	–4	2	6	–12	–6	–46	–50	...
Lisbon, . .	–16	–24	–8	32	–12	–8	4	4	–18	–8	–44	–48	...
Madrid, . .	–28	–18	–20	40	–12	8	2	8	–12	–10	–34	–48	...
San Fernando, .	–16	–24	–12	16	–12	–6	4	6	–12	–10	–32	–38	...
Gibraltar, . .	–14	–28	–6	17	6	5	4	10	0	–13	–36	–38	...
Alicante, . .	–32	–36	–24	40	–12	4	8	10	0	–30	–60	–32	...
Palma, . .	–32	–24	–24	36	0	6	8	6	5	–28	–66	–40	...
Athens, . .	–12	–20	–20	20	2	8	10	6	12	–8	–48	–14	...
Malta, . .	–10	–48	–32	20	–14	–10	4	7	24	–16	–70	–30	...
Palermo, . .	–20	–40	–18	32	–4	8	4	4	24	–18	–76	–38	...
Naples, . .	–18	–40	–30	36	–8	10	6	14	26	–12	–56	–28	...
Rome, . .	–16	–25	–22	40	0	13	11	16	26	–10	–56	–26	...
Lesina, . .	–28	–50	–36	28	–12	8	0	12	20	–12	–70	–44	...
Trieste, . .	–36	–52	–30	32	–10	10	8	6	14	–10	–80	–36	...
Venice, . .	–36	–44	–32	28	–20	4	0	6	14	–20	–82	–56	...
Perugia, . .	–28	–44	–30	32	–14	4	0	8	20	–16	–64	–40	...
Modena, . .	–32	–36	–24	28	–12	10	4	12	20	–6	–66	–40	...
Milan, . .	–36	–36	–24	36	–18	10	10	16	20	–4	–64	–44	...
Mondovi, . .	–32	–36	–24	32	–10	12	16	16	24	–6	–52	–40	...
Turin, . .	–36	–40	–24	36	–12	12	16	20	24	–28	–66	–40	...
Genoa, . .	–20	–36	–14	40	–6	12	16	18	24	–12	–70	–40	...
Geneva, . .	–44	–26	–24	14	–8	18	8	16	20	–12	–72	–50	...
Basel, . .	–48	–28	–28	46	–8	12	8	10	16	–12	–52	–18	...
Zurich, . .	–48	–34	–32	36	–10	8	2	12	14	–16	–56	–40	...
Berne, . .	–36	–24	–30	44	–6	14	8	14	20	–8	–56	–28	...
Leipzig, . .	–44	–16	–22	32	–8	24	26	28	6	4	–32	–2	...

These differences were then entered on small maps of Europe, from which, by the corrections thus found, the monthly means of the stations were brought to the means of the fifteen years. In certain districts, where necessary, differences were found for additional stations to these forty-three. Hence for all stations in the table for which the period of observation is entered as fifteen years, 1870–84, the means are simply the arithmetical averages of observations made during that period, or they are the approximate means for the same years. An examination of the above table, or better still, of a map on which the figures are entered, will show that the limit of error of any deduced approximate mean is in each case small.

In the United States, the term of years employed is not the fifteen years ending with 1884, but the thirteen and one-fourth years extending from October 1871, when the Signal Service of the War Department took charge of the Meteorological System of the States, to December 1884. A comparison of the averages of these thirteen and one-fourth years, with those of the fifteen years for about a dozen stations from which observations have been obtained for the whole fifteen years, shows that the two sets of averages closely agree. The isobars are therefore drawn from data virtually synchronous for the greater portion of the land surfaces of the Northern Hemisphere.

But generally over the Arctic Regions, South America, Africa, and Polynesia no such full information is available; the means of the observations actually made are alone printed, except in such regions as Southern Africa, Australia, and Japan, where the number and proximity of the stations seemed to warrant differentiation.

Correction for Range.—The means in Table VI. are, in each case, for the hours specified, no correction being applied here for variation due to diurnal range. But in preparing the figures for the drawing of the isobars, corrections were applied with the view of bringing the means for the hours observed to the daily means. In this part of the work the corrections in each case were taken from the copious Tables III. and IV. of hourly barometric range given in the Appendix, pp. 7 to 48. Care was taken in correcting for range to use only data furnished by a station or stations similarly situated geographically to the station the means of which were to be corrected. Thus Mullaghmore and Belmullet were corrected from Valentia, Parsonstown from Armagh, Holyhead from Liverpool, Cambridge from Oxford, Edinburgh from Makerston and Aberdeen, and other places in a like manner. Here the results of the Challenger observations, given in Table III., were of great service in correcting the means for small islands and coast stations over large regions of the globe. It need scarcely be added that the hourly variations for such stations as Gries and Klagenfurt in Austria, and Cordova in the Argentine Republic, situated in deep narrow valleys, were in no case employed, for the reasons already stated. Further, the means at places situated on plateaux more or less elevated, were not corrected from the hourly variations of such high level stations as Ben Nevis, Säntis, and Hoch Obir, which, being placed on true peaks, have

a totally different diurnal barometric curve from that of a place situated on a plateau, though its height and geographical position be otherwise similar.

Correction for Height.—Table V. gives the corrections for height which have been employed in reducing to sea level the barometric means of Table VI. This table is based on the formula given by Laplace in his Mécanique Celeste, which is published in Mr. Scott's Instructions in the Use of Meteorological Instruments, p. 80; modified by the results obtained from four years' observations at the Ben Nevis Observatory, 4406 feet high, as determined by levelling, and those at its low level station, near the sea at Fort William.

The four years' observations ending with 1887, give a decrease of temperature with height, at the rate of one degree Fahrenheit for every 270 feet of ascent. This rate has been adopted in arriving at the approximate mean temperature of the intervening stratum of air between the stations, the barometric means of which are being reduced to sea level. Since, in this discussion, the monthly means based on series of years' observation are alone dealt with, these approximate means may be regarded as sufficiently close to the true means for the purpose on hand. The mean of the intervening stratum of air being assumed to be the arithmetical mean of the temperature at the station and that of the sea level to which the reduction is made, the temperature of the intervening stratum was, in practice, found by adding to the station temperature a correction, at the rate of one degree Fahrenheit for every 540 feet in height.

The Ben Nevis Observatory and the Fort William stations are perhaps the best pair of stations yet established from which the requisite data can be obtained in connection with the inquiry as to the rate of the diminution of pressure with height; these two stations affording the conditions of great difference in height, combined with close proximity, and the positions of the thermometers in situations where the effects of solar and terrestrial radiation are minimised.

The corrections for height, for the Ben Nevis Observatory, for different sea level pressures and different air temperatures were empirically calculated from the observations. In applying the first results thus calculated, it became evident that it would be necessary to employ only those observations which were made when the wind blew at lower rates than thirty miles an hour, the reason being that the winds of higher velocities, as they brush past the buildings of the Observatory, suck the air out from the room where the barometer is hung, thus lowering the pressure; and the higher the velocity, the greater is the effect on the pressure thus produced.

A table of corrections for a height of 4406 feet was prepared in this way for sea level pressures, varying from 27·500 inches to 30·800 inches, and for air temperatures varying from 15° to 66°. For these same temperatures and sea level pressures, a similar table of corrections for Ben Nevis Observatory was constructed from Laplace's formula.

On comparing this latter table with the empirical one, it was seen that the two agreed throughout in giving the same differences between two different sea level pressures at the same air temperatures. But the two tables differed essentially when compared as to their differences for the same sea level pressures at different air temperatures. At the air temperature of 45° the two tables agreed, at lower temperatures the corrections from Laplace's formula were too large, and at temperatures higher than 45° too small. It was found that, when the additions to the corrections in the Laplace table for air temperatures lower than 45° were reduced by one-sixth, and the subtractions from the corrections as the temperature rose above 45 were also reduced by one-sixth, the two tables were virtually identical. It may be noted here that the differences among the corrections for height arising from the varying air temperatures thus deduced from the Ben Nevis Observations substantially agree with the differences in Hazen's Table for the reduction of Air Pressure.[1]

A table was then constructed from Laplace's formula for a sea level pressure of 30·000 inches for latitude 45°, and for air temperatures from −20° to 90°, and for heights up to 8000 feet. To the figures of this table were applied corrections for the different air temperatures, in accordance with the results of the Ben Nevis Observations. The result is given in Table V., which has been used in reducing the barometric means of Table VI. to sea level. The table is, however, only regarded as a provisional one, giving tolerably good approximations to the true corrections for height.

But the really serious difficulties encountered in reducing barometric observations to sea level are presented by the air temperatures, and unless these difficulties are kept steadily in view, no little confusion will be the result in representing the course of the isobars. The more serious of these difficulties are experienced in dealing with stations situated in deep, narrow valleys, and stations on elevated plateaux.

This is well shown by the observations made at Obirgipfel in the Tyrol, which is a high level station on a peak 6706 feet high, and at Klagenfurt, about 7 miles distant, in a deep valley adjoining, at a height of 1437 feet, there being thus a difference of 5269 feet in height between them. Now the differences of temperature between the monthly means of these two situations for the five years 1880 to 1884 are these, the figures showing the excess of the temperature of Klagenfurt above that of Obirgipfel :—

0·7, 5·8, 12·6; 19·4, 22·0, 21·2; 18·5, 17·6, 16·4; 13·9, 7·7, 6·1,

and for the year 13·4. Now, since the station at Obirgipfel is situated on a true peak, it follows that the temperature there recorded will closely approximate to the temperature of the free atmosphere at that height. But at Klagenfurt it is far otherwise, for being situated in a deep narrow valley, the night and winter temperatures, as already explained, are greatly too low, and the day and summer temperatures are too high. The mean winter temperature at Klagenfurt is only 4°·2 lower than that of the

[1] Washington, 1882.

neighbouring station 5269 feet higher, and in January it is only 0°·7 lower. Hence, if in these months the temperature of Klagenfurt be used in calculating the temperature of the intervening stratum of air from that place to sea level, it would be much too low, and in all probability the sea level pressure for Klagenfurt would be made nearly 0·030 inch above what it ought to be. But even if it be supposed that the temperature of the intervening air stratum could be tolerably approximated to, the barometric observations themselves made in such situations are so strictly local, being largely increased during the cold hours of the day and seasons of the year and diminished during the warm times of the day and of the year, that they would only mislead if used in drawing the isobaric lines of the region where they are situated. Hence in this work the barometric means of such stations as Gries and Klagenfurt in Austria, and Cordova in the Argentine Republic, though printed in the table, have not been used in drawing the isobaric lines; and all care was accordingly given to keep the maps, from which the isobarics were drawn, clear of sea level pressures deduced from observations made in such situations. It is probable that this consideration explains what look like anomalous observations at a number of places, about the local situation of which there is no information.

Gravity Correction.—The barometric means in Table VI. have not been corrected for gravity. But as the sea level pressures entered on the maps were reduced to gravity at lat. 45°, the isobars on the maps are corrected for gravity. The following are the corrections for gravity at a pressure of 30·000 inches which have been used:—

Lat. N. or S.	Cor.	Lat. N. or S.	Cor.	Lat. N. or S.	Cor.	Lat. N. or S.	Cor.
°	inch.	°	inch.	°	inch.	°	inch.
0	−·080	25	−·052	50	+·014	75	+·070
1	·080	26	·049	51	·017	76	·071
2	·080	27	·047	52	·019	77	·072
3	·080	28	·045	53	·022	78	·073
4	·079	29	·042	54	·025	79	·074
5	·079	30	0·40	55	·027	80	·075
6	·078	31	·038	56	·036	81	·076
7	·078	32	·035	57	·033	82	·077
8	·077	33	·033	58	·035	83	·078
9	·076	34	·030	59	·038	84	·078
10	·075	35	·027	60	·040	85	·079
11	·074	36	·025	61	·042	86	·079
12	·073	37	·022	62	·045	87	·080
13	·072	38	·019	63	·047	88	·080
14	·071	39	·017	64	·049	89	·080
15	·070	40	·014	65	·052	90	·080
16	·068	41	·011	66	·054	...	...
17	·066	42	·008	67	·056	...	...
18	·065	43	·006	68	·058	...	...
19	·063	44	−·003	69	·060	...	...
20	·061	45	·000	70	·061	...	...
21	·060	46	+·003	71	·063	...	...
22	·058	47	·006	72	·065	...	...
23	·056	48	·008	73	·066	...	...
24	·054	49	·011	74	·068	...	...

Correction for Mean Temperature.—The period selected for the mean temperature observations is the fifteen years adopted for pressure, beginning with 1870 and ending with 1884. From the remarkable extension of meteorological observation in recent years, data of greater fulness and of higher quality are now available for drawing isothermals over the globe, which therefore represent the geographical distribution of temperature with a degree of approximation to the truth not previously attainable.

The methods of discussing the observations are, to a large extent, the same as those detailed and explained in dealing with the observations of atmospheric pressure, with, however, several important differences.

Since the observations made use of preferentially in this inquiry are the daily maximum and minimum temperatures, special attention was given in making the extracts of the monthly means to detect, where possible, any cases that may have occurred of the minimum thermometer having got out of order, as not unfrequently happens, and allowed, from inadvertence, to remain out of order for some time. These errors, together with typographical errors and many of the errors of computation, were the more readily detected by the practice adopted of extracting the means of the separate years in succession for each country or region by itself, so that the curve of monthly variation of each year being easily kept in mind, any deviation from it was seen with little difficulty.

When observations are read to the tenth of a degree, the personal errors of observation may be neglected. But when the readings are only to whole degrees, two kinds of errors are certain to occur where provision is not made to secure that each observer is properly taught. These two sorts of error are, (1) taking the degree which the mercury or spirit has just passed; or (2) taking the degree immediately above the top of the mercury or spirit. In the former case, the means deduced from the observations will be half a degree too low, and, in the latter case, half a degree too high. In many cases these faulty methods of observing may be detected from the annual means, corrected for height, entered in maps of the country whose temperature is being discussed.

By the same method the errors of faulty thermometers may be detected. In all cases where for this assumed cause the means have been corrected to the extent of 1° or upwards, the amount of the correction is stated in the last column of the table under "Corrections applied." In such cases as Portland in Victoria, Australia, where the published mean temperatures were for many years about 5° too high, but where the error was rectified some time ago, the correction was applied to the observation of the years in error, but no note is made of it in the last column of the table.

Again, in cases where "mean temperatures" alone are published, and no information given whence these have been derived, a change of hours sometimes takes place

of which no notification is given, and apparently no allowance is made for the change. Thus at Hobart Town for some years, the hours of observation appear to have been 9 A.M. and 1 and 5 P.M., and the mean of the observations at these hours was adopted as the mean temperature, with the result of winters apparently 2° and summers 6° warmer than before. The figures for Hobart Town in the table have been brought to mean temperatures by correcting each year's observations by the table of corrections for hourly range at this place. It may be mentioned that these faulty mean temperatures at Portland and Hobart Town for long thrust the isothermals of this part of the globe seriously out of their proper positions.

In a large number of instances the monthly means in the table are the means of particular hours of observation uncorrected in any way, such as 6 A.M., 2 P.M., and 10 P.M.; 7 A.M., 1 P.M., and 9 P.M.; 4 A.M., 10 A.M., 4 P.M., and 10 P.M.; 8 A.M. and 8 P.M.; 9 A.M. and 9 P.M. The means were corrected for daily range where such corrections were required, and after being corrected for height, the resulting means were entered in their places on the map.

In correcting for height, the correction adopted is at the rate of 1° Fahr. for every 270 feet in height above mean sea level; and this correction has been uniformly applied to the temperature observations for all seasons and countries. The rate unquestionably varies with season and climate; but as regards the manner and degree of this variation, our information is so scanty, and the worked-out results in many cases are so doubtful, and sometimes even so inconsistent with each other, that it is more in accordance with the present state of our knowledge to adopt provisionally a uniform rate of correction throughout, than a rate varying with season and climate.

Of the causes producing variability in the rate of diminution of temperature with height, the more prominent are season, hygrometric state of the atmosphere, and situation. During the transition from winter to summer, when the great annual rise of temperature is in progress, the rate of diminution of temperature with height is greatest, for the simple reason that at this season the lower layers of the atmosphere are more quickly heated by simple proximity to the earth's surface, thus increasing the difference between the temperatures at low and high levels. On the other hand, in autumn, when the great annual fall of temperature occurs, the lower strata of the atmosphere are more cooled by the now rapidly cooling surface of the earth, and accordingly the difference between the temperatures of the low and high levels is proportionally lessened.

Observations prove that the more aqueous vapour there is in the atmosphere in the form of cloud, and to a large degree even in a purely gaseous form, the more is the earth's surface protected from the effects of solar and terrestrial radiation. It follows therefore that in rainy climates, and during the rainy season in the tropics, the rate of diminution of temperature with height is comparatively a stable quantity hour by

hour, day by day, and season by season, at least as compared with what obtains in dry climates and seasons. In truth, as regards dry climates the diurnal variations in the fall of temperature with height, particularly in the warm months of the year, are so varying and uncertain, that it will probably for ever remain a hopeless problem to reduce a barometric observation made at any particular hour to sea level at places, say 1500 feet in height and upwards, with a tolerable approximation to the truth. The reason is, that it is not then possible to deduce from the observations made the approximate mean temperature of the stratum of air between the station and sea level. In constructing daily weather charts, the difficulty is in some degree met by combining with the temperature at the time of observation, the temperature at one or two previous observations. In this work all these difficulties are very greatly reduced, since what are dealt with are only the mean pressures and temperatures of series of years. In drawing the isobars and isothermals, greater weight has been given to the observations made at low than at high stations.

As respects situation, the least variation in the rate of diminution of temperature with height occurs at places near the sea, and particularly on the windward coasts of land areas, and the rate varies from the normal on advancing into inland climates. At high level stations situated on true peaks, the rate closely approximates to the normal; but on elevated plateaux the deviation is considerable, and increases with the dryness of the climate and the intensity of solar and terrestrial radiation.

Now as regards this discussion, observations from such stations as the above may be considered as affording sea level pressures and temperatures sufficiently close to the truth as to warrant the using of them as part of the data from which the isobars and isothermals of the globe may be drawn.

But it is quite otherwise when we come to deal with observations made at stations situated in deep valleys, such as Gries, Klagenfurt, and Cordova, at which temperature is abnormally lowered when terrestrial radiation is in excess, and abnormally raised when solar radiation is strong. For this reason, not only have those stations been wholly left out in drawing the isobars and isothermals, but also all others known to be in situations more or less similar. Since information is often not supplied regarding the physical configuration of the earth's surface where the station is situated, it was found necessary to resort to an examination of the diurnal range of the barometer, as shown at the observed hours of the station, in order to arrive at some knowledge as to whether the station was situated in the open or in a deep valley. In this way stations were marked as supplying data either altogether unsuitable, or only partially suitable in this discussion.

It is scarcely necessary to add that observations made at stations in deep valleys, not only mislead in drawing the isobars and isothermals of a country, but they are absolutely useless, and even worse, when used as data contributing to the solution of

the problem of the rate of diminution of temperature with height. This consideration has unfortunately been often lost sight of, particularly in framing tables of corrections for height intended for different climates and seasons.

In differentiating for stations at which observations were not made for the whole of the fifteen years ending with 1884, in order to bring their means to the means of these years, the same methods were adopted as those used in preparing the monthly means of atmospheric pressure. Very special care was taken to differentiate coast stations only with coast stations, and inland stations with inland stations. Also when, in differentiating, the observations of only a few years were available, the geographical distributions of abnormally high or abnormally low monthly temperatures during these years were carefully noted in their bearings on the monthly means being worked out.

Wind.—The observations of wind are given in Tables VII. and VIII. In all cases where possible, the mean direction of the wind has been worked out in the form given in Table VII. Climatologically, the most satisfactory way of presenting this most important element of climate is by giving the mean number of days each month which each wind, N., N.E., E., etc., prevails. If only the mean direction is given, as is done in Table VIII., the variability of this important factor of climate from the prevailing direction is absolutely neglected, and the climatic value of the record seriously lowered.

In this discussion no account has been taken of the force or velocity of the wind, such observations being still too meagre and too crude for any satisfactory use being made of them.

It has not been possible, owing to the want of the observations, to give for many regions the same weight as regards time to the means of the winds, as to the means of pressure and temperature. This has, however, been done as respects the United States, the North Atlantic, and a large portion of the Europeo-Asiatic continent, where these three elements of climate are substantially synchronous, and where, therefore, their relations can be more closely compared. So far, however, as affects the mean direction of the wind, it soon appeared in the course of the discussion that a shorter term of years is required to give a close approximation to the true means, than in the case of the pressure or the temperature. Hence an attempt has been made, in those regions where the observations are not obtainable for the whole period of the fifteen years, to collect the averages for as long terms of years as possible. The hours of observation from which the means have been calculated, when known, are stated; and where a selection of hours could be made, those hours were chosen which appear to give the best daily mean in view of sea and land breezes. Wherever it could be attempted, means deduced from hourly observations have been given, which alone really inform us as to the mean daily direction of the wind.

In preparing the tables of pressure, temperature, and wind, the aim has been to make the selection of stations represent fairly well the more important climatological features of the region under discussion. There are, however, large regions where the data are given with a greater fulness than this, such as the British Islands, Denmark, Holland, Spain, Italy, Cyprus, India, the United States, and the Argentine Republic. This is done for the purpose of showing more in detail, than the charts can show from their size, the influence of land and water, mountains and plains, on the climatic problem. As regards Denmark, the means, particularly of the wind, have been more fully worked out, owing to the position of this country between the mountains of Scandinavia and the mountains to the south of it, and the important resulting consequences of that position on the tracks of the cyclones and anticyclones of Europe.

Another object aimed at in the fuller discussion given to certain countries, was a search for guiding information as to the influence of land and water, plain and mountain on these lines, in order that the most probable course might be assigned to the isobars and isothermals in those parts of the globe where observations are too few and far between to serve of themselves for the drawing of these lines.

In drawing the isothermals and isobars and entering the arrows showing the prevailing winds on the maps, much of the information contained in the following works has been utilised, in addition to what is given in the Tables :—

Contributions to our knowledge of the Meteorology of Cape Horn and the West Coast of South America, by Richard Strachan. Contributions to our knowledge of the Meteorology of the Antarctic Regions, by Richard Strachan. Charts of Meteorological Data for Square 3 Lat. 0° to 10° N., Long. 20° to 30° W. Charts of Meteorological Data for the nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W. Contributions to our knowledge of the Meteorology of Japan, by Captain Tizard, H.M.S. Challenger. Contributions to our knowledge of the Meteorology of the Arctic Regions, by Richard Strachan. Charts of Meteorological Data for the ocean district adjacent to the Cape of Good Hope. Charts showing the Mean Barometrical Pressure over the Atlantic, Indian, and Pacific Oceans, by Lieutenant Baillie, R.N. *Published under the authority of the Meteorological Council.*

Weather Charts of the Bay of Bengal and adjacent sea north of the Equator. Weather Charts of the Arabian Sea and the adjacent portion of the North Indian Ocean. *Published by the Meteorological Department of the Government of India.*

Various publications on Ocean Meteorology and on Ocean Routes, issued by the Meteorological Institutes of Holland, Germany, France, and Norway.

The Winds of the Globe, by Professor Coffin and Dr. Alexander Woeikof. *Published by the Smithsonian Institution.* As regards this large work, it is only the more important data referring to the oceans which has been utilised.

And also for the Winds, the Meteorological Charts of the North Pacific Ocean from the Equator to Lat. 45° N., and from the American Coast to Long. 180°. By Commodore Wyman, U.S. Navy, Washington, 1878.

It is right to acknowledge here the invaluable assistance received from the meteorological writings of Dr. Hann, who holds the first place among meteorologists for the importance, extent, and trustworthiness of his contributions to the climatologies of the globe.

In the preparation of the Tables I have been assisted by Mr. H. N. Dickson and Miss J. H. Buchan of the Scottish Meteorological Society's office. Miss Buchan has assisted during the whole time of the discussion. She copied out the whole of the Challenger observations, chronologically arranging them according to subject, and assisted in working out the hourly and other averages; she also collected and computed a large part of the new wind averages given in Table VII., a considerable proportion of which were laboriously calculated from daily observations, and several even taken from daily curves of wind direction; and she aided generally in checking the correctness of the computed averages. I had the benefit of Mr. Dickson's help during 1887 and 1888. He computed the air temperatures of the North Atlantic from the Bulletin of International Meteorology; further assisted in the preparation of Table V.; carried out the work of differentiation for the mean temperatures at a considerable number of places in the Russian Empire; charted the greater part of the temperatures; and prepared the first draught of the isothermals for large portions of the globe.

THE TEMPERATURE, PRESSURE, AND PREVAILING WINDS OF THE GLOBE.

These prime elements of climate will, from their intimate relations to each other, be more satisfactorily dealt with together than separately. It is scarcely possible to over-estimate the importance of a knowledge of the distribution of atmospheric pressure, or of the mass of the earth's atmosphere over the globe, in its varying amounts from month to month. Observations prove conclusively that winds are simply the movements of the atmosphere that set in from regions where there is a surplus towards regions where there is a deficiency of air; and the nearer the observations of pressure and wind approximate to true averages, the closer is the relation seen to be subsisting between these two distinct phenomena. Again, since prevailing winds to a large extent determine the temperature and rainfall of the regions they traverse, isobaric maps may be considered as furnishing the key to the climatologies of the globe as well as to many of the more important questions of meteorological inquiry. The distribution of temperature in the atmosphere may be regarded as the fundamental problem of meteorology, seeing that the varying pressures, humidities, and winds are either direct or indirect consequences of the varying distribution of temperature. As regards the distribution of the temperature over the land surfaces of the globe, the problem was approximately solved by the

publication of Humboldt's isothermal lines. But as regards the ocean, which comprises three-fourths of the earth's surface, the monthly and annual distribution of temperature in the atmosphere over it can scarcely be said to have been yet seriously looked at.

In these circumstances, the thanks of the climatologist is specially due to the Signal Officer of the United States for the monthly averages for the North Atlantic, which were published for several years in the International Bulletin, and to the Meteorological Council of London for monthly averages for the Red Sea. The required data have thus been available in this work for drawing the isothermals for these important parts of the ocean. A comparison of these means, Table IX., pp. 228–9 and 254–9, and of the Challenger mean air temperatures, Table I., with the temperatures of the sea for the same positions and months, shows that it is absolutely necessary, in the advance of meteorology, that the determination of the monthly temperatures of the air over the ocean be undertaken and carried out. The differences observed between the temperature of the surface of the sea and that of the air over it, so far as a comparison can yet be made in the North Atlantic and Red Sea, point to a much greater prevalence of ascending and descending movements in the atmosphere than is generally supposed. As regards the other oceans, the isothermals of the temperature of the atmosphere must in the meantime continue to be drawn essentially from observations made on the islands and along the coasts of these oceans.

Some interesting results are arrived at by comparing the temperatures of the ocean and air observed by the Challenger. The whole of the observations have been sorted into 174 groups according to geographical position, and the differences entered on a chart of the route of the expedition. In the Southern Ocean, between latitudes 45° and 60°, the temperature of the sea was lower than that of the air. The mean difference was 1°·4, due probably to the temperature of the air being higher owing to the prevailing W.N.W. winds, and that of the sea lower owing to the numerous icebergs. To south of lat. 60° the sea was about 2° warmer than the air, owing perhaps to an increased prevalence of southerly, and hence colder winds in these high latitudes.

The temperature of the sea exceeded that of the air from June 1874 to March 1875, or during that part of the cruise from Sydney to New Zealand, then to the Fijis and through the East India Islands to Hong Kong, and thence to the Admiralty Islands. During the whole of this time, except when near the north of Australia, the sea was much warmer than the air, the excess generally being from 2° to 3°, rising near Tongatabu to upwards of 4°. In passing the north of Australia in September, in which season the wind is off the land and the air therefore dry and sunshine strong, the sea was colder than the air. In the Atlantic, between lat. 20° N. and 20° S., the sea was everywhere warmer, the mean excess being about a degree; and in the Pacific, between lat. 30° N. and 30° S., the sea was also warmer, the excess being a degree and a half.

On the other hand, in the Atlantic from lat. 20° to 40° N., the sea was on the

mean half a degree colder than the air. Similarly in the Pacific, from lat. 30° to 40° N., the temperature of the surface of the sea was half a degree lower than that of the air. The explanation of these differences is probably to be found in the degree of humidity of the atmosphere, the direction of the wind, and the degree in which descending aerial currents mingle with the winds that sweep across the surface of the ocean. It is evident that a wind, issuing from an anticyclone in which descending currents are strong and decided, necessarily possesses quite different hygrometric and temperature qualities from those of a truly horizontal wind which has traversed a large extent of the ocean.

The above remarks refer only to those observations which were made strictly on the open sea. Near land great differences, either way, were observed, which varied with season. At Hong Kong, for example, during the latter half of November 1874, the sea was 3°·7 warmer than the air, the low air temperature being occasioned by the lower temperature of the land and the northerly winds prevailing there at this season. On the other hand, at Valparaiso in November and December 1875, the sea was 5°·8 colder than the air, the low sea temperature being probably occasioned by the up-welling to the surface of the colder water of greater depths by the winds blowing off the land on this coast, similar to what Dr. Murray has proved by extensive observations to prevail in the Scottish lochs.[1]

The distribution of temperature over the globe is shown by Maps I. to XXVI., representing the months and the year. The region of highest temperature, which may be taken as comprised between the north and south isothermals of 80°, forms an irregularly shaped zone, lying in tropical and partly in sub-tropical countries. On each side of this warm zone temperature diminishes towards the poles, and the lines showing successively the gradual lowering of the temperature are, roughly speaking, arranged parallel to the equator, thus showing unmistakeably the predominating influence of the sun as the source of terrestrial heat. While, however, the decrease of temperature corresponds in a general way with what may be conveniently termed the solar climate, there are great deviations brought about by disturbing causes, and among these causes the unequal distribution of land and water holds a prominent place.

January.—During the time of the year when the sun's heat is least felt, and the effects of terrestrial radiation attain the maximum, the greatest cold is over the largest land surfaces which slant most to the sun. Hence the lowest mean temperature that occurs anywhere or at any season on the globe, $-61°·2$, occurs in January at Werkojansk, lat. 67° 34′ N. and long. 133° 51′ E., in north-eastern Siberia, at a height of 460 feet above the sea. In January 1886, temperature fell at this place to $-88°·8$, being absolutely the lowest temperature of the air hitherto observed. The lowest mean temperature in America is nearly $-40°$, and this cold region is situated a little to the north of the magnetic pole.

[1] "On the Effects of Winds on the Distribution of Temperature in the Sea- and Freshwater Lochs of the West of Scotland." *Scottish Geographical Magazine*, July 1888.

In the northern hemisphere the ocean maintains a higher temperature than the land in regions open to its influence, as is seen not only in the higher latitudes to which the isothermals push their way as they cross the Atlantic and Pacific, but in their irregular courses over and near the Mediterranean, Black, Caspian, and Baltic Seas, Hudson's Bay, the American Lakes, and all other large sheets of salt and fresh water. The influence of the ocean and ocean currents in keeping up the temperature during the winter months is most strikingly seen in the North Atlantic, where the isothermal of 35° reaches a much higher latitude in mid-winter than anywhere else on the globe. The conserving influence of sheets of water on the temperature in all seasons is more strikingly shown when the isothermals are drawn for single degrees on maps of a larger scale.

In the southern hemisphere the highest isothermals are 90° in Australia and South Africa, and 85° in South America. It is to be noted that in January, the summer of this hemisphere, the lowest isothermal is 25° in the Antarctic Ocean to the east of South Victoria; whereas in July, the corresponding summer month of the northern hemisphere, the lowest isothermal is only 35°, or 10° higher than in the Antarctic Ocean. The difference is due to the icebergs and icefields of Antarctic regions. In Antarctic and sub-Antarctic regions the change of temperature through the months of the year is comparatively small, the annual range being only about 10°.

In this month the least variation of temperature occurs in the equatorial regions of the Pacific, and in all seasons the variation there is small.

In January the mean pressure of Central Asia rises to about 30·50 inches, which is absolutely the highest mean pressure for any month anywhere over the globe. Now, since the prevailing winds in this anticyclone, which virtually overspreads nearly the whole of Asia and Europe, flow outwards in all directions, bringing S. and S.W. winds over Russia and western Siberia, it follows that the temperature of these inland regions is considerably higher than would otherwise be the case. On the other hand, since the prevailing winds are N.W., N., and N.E. on the east and south of Asia, the temperature of these regions is thus abnormally depressed. Indeed, so strong is this influence of wind direction and ocean combined, that the isothermals run, roughly speaking, north and south in the west of the Europeo-Asiatic continent, and do not assume an east and west direction till about 70° or 80° long. E.

Since in Siberia light airs and calms prevail, and the general drift of the atmosphere is north-north-eastwards towards the higher latitudes of the Arctic regions, the temperature continues rapidly to fall in that direction, with the result that the lowest mean temperature is not coincident with the centre of greatest pressure to the south of Lake Baikal, but occurs at Werkojansk, about thirty degrees of latitude to the N.N.E.

The other anticyclonic regions are North America, in the centre of which pressure rises to 30·20 inches; two in the Pacific to the west of California and of Chile respectively; in the South Atlantic to the west of Cape Colony; and in the Indian Ocean to the west of

Australia. Such regions, and they are well marked, are found in all months and in all oceans about lat. 30° to 40° N. and S., immediately to the westward of the continental masses in these latitudes. The only exception to this is in the North Atlantic in January, and the isobars of this part of the ocean for the months immediately following suggest that this is a true exception. Lieut. Baillie's Isobaric and Current Charts of the Ocean show in an instructive manner that the central spaces of these anticyclonic regions are nearly always avoided by seamen, and therefore practically long known to them. It is scarcely necessary to add that the prevailing winds blow out of them in all directions; and since these winds have the temperature of the upper regions whence they have come increased only by the increasing pressure to which they are subjected as they descend, their temperature often differs considerably from that of the surface of the sea over which they blow.

The lowest isobar, 28·90 inches, is found in the Antarctic regions to the east of New Victoria. The observations of all the months show that there is a permanently low pressure over these regions, lower than is to be found anywhere else on the globe. On all the maps pressure is drawn to the isobar of 29·30 inches, since observations appear to warrant this; but during the summer months of the southern hemisphere lower isobars have been drawn for the portions of Antarctic regions for which observations have been furnished by the various expeditions which have been made into these southern seas.

The most wide-spread low pressure area is in tropical regions, where pressure, except in the eastern half of the Pacific, falls below 29·85 inches. In this extensive region, which covers about two-fifths of the whole surface of the globe, there are three areas where pressure falls still lower. These are the north-west of Australia, Southern Africa, and South America. A line drawn round the globe along the path of least pressure of this zone separates the north and south "trades," indicating the belt or still narrower zone towards which these great aerial currents blow. In the Atlantic and eastern half of the Pacific, where the barometric gradient is well marked, these winds are mapped out with equal distinctness; but in the western part of the Pacific, where the gradient is low and indistinctly marked, the direction of the prevailing winds is irregular and obscure, and it is probable that increased observation will the more strongly illustrate this remark.

It will be observed that the path of least pressure lies north of the equator in the Atlantic and Pacific Oceans. But in the Indian Ocean it is, at this season, south of it, lying in a line from Seychelles to the north of Australia. In this restricted region the winds are especially interesting as illustrating Buys Ballot's Law of the Wind in the Southern Hemisphere.

The next most important low-pressure system overspreads the northern part of the Atlantic and regions adjoining, the lowest mean pressure being 29·50 inches from

Iceland to the south of Greenland. It is this region of low pressure which gives to Western Europe its prevailing south-westerly winds and to North America its north-westerly winds in winter. By these the temperature of Western Europe is abnormally raised by its prevailing winds coming from the ocean, and from lower latitudes, and the temperature of North America is abnormally lowered by its prevailing winds coming from Arctic regions and from land in the season when the effects of terrestrial radiation are at the maximum. The opposite action of these winds, which are component parts of the same atmospheric disturbance about Iceland, is shown by the temperature on the coast of Labrador being only $-13°$, whilst in the same latitude, in mid-Atlantic, it is $45°$, or $58°$ higher. This low-pressure region extends eastwards beyond Nova Zembla, and from the resulting winds which follow that extension the rigours of the winter climate of the north of Russia and Siberia as far east at least as Cape Severo are materially counteracted.

The remaining cyclonic centre is in the North Pacific, the lowest isobar being 29·55 inches south of Alaska. The effects of this low pressure on the prevailing winds, and through these on the temperature and rainfall of the north-east of Asia and the north-west of America, is exactly similar to the effects of the low pressure of the Atlantic on the climates of Europe and the United States.

The influence on the pressure of the Spanish and Italian peninsulas on the one hand, and on the other the influence of the Mediterranean, Black, and Caspian Seas is strongly marked ; and equally so do the Arabian Sea, India, and the Bay of Bengal leave their mark on the isobars and the winds.

February.—The distribution of temperature in this month is similar to that of January, the chief difference in the northern hemisphere being that in inland situations the influence of the returning sun begins to be distinctly felt in the higher temperatures which now prevail; whereas over the sea and in insular situations, particularly in the higher latitudes, temperatures are even lower than in January, it being in this month that the temperature of the sea falls to, or nearly to, the annual minimum. At Werkojansk the mean temperature has risen from $-61°{\cdot}2$ to $-51°{\cdot}9$; and the greater strength of the sun's rays is also well seen in the altered form and positions of the isothermals in the continental regions of North America between lat. 20° and 40°.

The great changes in the distribution of pressure in this month are a considerable diminution over North America south of lat. 50°; in the western part of the North Atlantic, and over the whole of that ocean between lat. 40° and 60° ; over Africa, except the south ; Europe, except north of a line from the south of Scotland eastward to Wiatka in Russia, and thence northward to the Arctic Ocean ; all Asia, except the islands on its east coast, and the north-east of the continent. Elsewhere pressure has risen, notably in the eastern half of the Atlantic, south of lat. 40°, resulting in the formation of an anticyclonic region, which is further developed in the following months ; over

Australia, South Africa, and the greater part of South America. Generally speaking, pressure has diminished where temperature has begun most markedly to rise, and the air removed appears to be added to the portions of the atmosphere overspreading the northern half of North America, Europe, Australia, and the region of the Atlantic already referred to. None of the changes, however, are so material as to bring about any serious difference in the prevailing winds as compared with those of January.

March.—In March the lowest isothermal in Asia has now risen to $-30°$, and in America to $-25°$, and over all the more strictly continental regions of the northern hemisphere the great annual increase of temperature is rapidly proceeding; but in the more strictly insular and oceanic climates of the globe the change of temperature from that of February is comparatively small, as is well shown by the isothermals of the British Islands, Australia, and New Zealand. The marked increase of temperature on advancing inland, from both the east and west coasts of the United States, and the remarkable flexures of the isothermals of Europe and Asia, in the transition from winter to summer, are very instructive.

The great changes in the distribution of the pressure in this the first of the spring months, are a large diminution overspreading the whole of Asia and Europe, except the British Islands, the North Atlantic to the south of lat. 40°, and North America to the south of lat. 50°. On the other hand, there occurs a very large increase of pressure to northward of these Atlantic and American latitudes, amounting to upwards of a tenth and a half in mid-Atlantic between the British Islands and Labrador; and there is also an increase, though less decided, over nearly the whole of the southern hemisphere, the exception being the South Atlantic, lying between the increasing pressures of Africa and America, which show rather a slight diminution.

In this month the extra-tropical waters of the oceans reach the annual extremes of temperature, those of the North Atlantic falling to the annual minimum, and those of the South Atlantic rising to the annual maximum. Now at this season this region of the North Atlantic, lying between the rapidly-increasing temperature and falling pressure of the Europeo-Asiatic and the American continents, receives an increment of pressure much larger than takes place in any other month of the year.

There are seven anticyclonic areas—in Central Asia, where pressure is rapidly falling from its high winter maximum; in British America, where it is rising to the maximum in spring; two in the Pacific and two in the Atlantic immediately to westward of the continents; and in the Indian Ocean west of Australia. The systems of low pressure are in the north of the Atlantic and Pacific Oceans, in Central Africa and round the South Pole.

April.—This is the first month when the annual increase of temperature is largely felt over both insular and continental regions. The increase is, however, larger in continental climates, and particularly where the rainfall is comparatively small and the

skies clear. Hence, latitude for latitude, temperature is highest in India and in the inland United States to the westward of the Mississippi. The most uniformly distributed temperatures are over the Indian Ocean to the north of lat. 20° S., and in the Pacific between lat. 20° N. and S. On the other hand, the isothermals are much crowded over North America generally, in Senegambia, and South Africa.

As compared with March, pressure has risen over nearly the whole of the southern hemisphere; and in the northern hemisphere, to the north of a line drawn from the mouth of the Mackenzie River to Anticosti, then south-west to near Cape Hatteras, then through the Atlantic eastward to long. 33° W., then northward to lat. 55° N., then eastward to the Ural Mountains, and thence to Cape Severo. Over this latter region the largest increase, being from 0·15 to 0·20 inch, is from West Greenland to the mouth of the Obi. Pressure has now fallen from two to three-tenths in the centre of Asia, whereas in the centre of North America and of Europe the fall only slightly exceeds one-tenth. Over the Arabian Sea and the Bay of Bengal, while pressure has fallen 0·04 to 0·08 inch, it has fallen over India between these two seas from 0·08 to 0·15 inch, or nearly double; and in India the greatest decrease is in the north-west, where the air is driest and temperature is rising most rapidly. The conserving influence of the Mediterranean on the pressure is equally striking. Again, in the North Atlantic, the cold Labrador current, with its low temperature and increased pressure, and the warm southerly current on the east side, with its greatly diminished pressure, suggest interesting connections between changes of pressure and relative surface temperatures.

The high pressure of Central Asia has now all but disappeared, and the high pressure area of the Arctic regions, extending from Lake Superior to Northern Siberia, reaches the annual maximum, the absolute maximum isobar extending from the Arctic Circle in long. 105° W. in a W.N.W. direction to the Liakov Islands. The other anticyclonic regions are Southern Australia, in the Indian Ocean to the south of Madagascar, and the four regions in the Atlantic and Pacific immediately to the west of the old and new continents. It is remarkable that the highest of these, where the mean pressure rises to 30·30 inches, is the one to the west of California, the next highest being the anticyclone in the Indian Ocean, where pressure only reaches 30·15 inches.

Except the Antarctic depression, none of the low pressure areas are strongly marked. The cyclonic regions of the North Pacific and Atlantic are now much reduced in depth and extent; while, on the other hand, that of India has deepened and extended, and new centres of depression have begun to appear in the region of the Rocky Mountains, and in the Pacific to the west of Panama.

May.—As regards temperature, the most noteworthy feature in this the transition month from spring to summer of the northern hemisphere, is the high temperature which prevails in all tropical and sub-tropical regions, particularly where the rainy

season has not yet begun, or where the rainfall is not large. Of this, India, Central Africa north of lat. 10° N., and the more strictly inland regions of North America from about latitude 15° N. in a northerly direction, are the best examples; and in a less degree the more continental portions of the Spanish and Scandinavian peninsulas. The contrast in this respect of India and the Eastern Peninsula is very striking, the relatively low temperature of the latter being probably due to the "lie" of its great valleys in the line of the summer monsoon. The influence of the Red Sea and Persian Gulf in this and subsequent summer months in breaking the continuity of the isothermals and changing their course is very remarkable. The low temperature of the north-eastern portion of America and over the north of Siberia as compared with Western Europe is probably occasioned by the northerly winds which have now set in towards the rapidly developing centres of low pressure in the interior of the continents taken in connection with the sun's position in the heavens.

Accompanying these changes of temperature, pressure has fallen greatly over nearly the whole of the continents of the northern hemisphere, the amount of the fall being generally the same as in the previous month; and again the fall over the Arabian Sea and Persian Gulf is only a half, or even less, than in India, lying between these two seas. A diminution of pressure has also taken place over the south-east of Australia, New Zealand, the southern portion of South America, and over the sea immediately to the south of Cape Colony.

On the other hand, pressure has continued further to increase over nearly the whole of South America and Africa. But the region of the great increase of pressure, or the region to which has been transferred the mass of the earth's atmosphere which has been removed from the Asiatic and American continents, is the Atlantic Ocean from the Arctic Circle south and to at least lat. 20° S., exclusive of the Caribbean Sea, but inclusive of the United States east of the Mississippi and Ohio, Lower Canada, and nearly the half of Europe, to the south of a line drawn from Shetland to the Sea of Azov. The maximum increase, being nearly two-tenths of an inch, occurs in mid-Atlantic, about lat. 45° N. In the Atlantic, from lat. 55° to 70° N., pressure now attains its annual maximum.

A high pressure overspreads nearly the whole of Arctic regions, the maximum, 30·10 inches, extending from the mouth of Back River to Nova Zembla. The other anticyclonic areas of high pressure, in addition to the four in the Pacific and Atlantic Oceans, are found in the centre of South America, in South Africa, to the south of Madagascar, and in Australia. Of these the least pronounced is the one in Australia, and that most pronounced is in the Pacific to the west of California, where pressures are respectively 30·05 and 30·30 inches. Pressure has increased over the anticyclonic region of the North Atlantic; and as pressure all round has considerably fallen, this anticyclone is now a strongly marked one.

The low-pressure system of India has shifted a good way to north-westwards, and deepened to 29·60 inches, and those of Central Africa to 29·70 inches, of North America to 29·80 inches, and of the Pacific, near Panama, to 29·85 inches. On the other hand, the cyclonic systems of the North Pacific have shallowed to 29·75 inches, and that of the North Atlantic to 29·90 inches, and in the adjoining parts of Europe there are five other centres, each of very limited extent, where pressure has fallen slightly lower than 29·90 inches.

June.—This is the first summer month of the northern hemisphere, and the isothermals have now taken their summer positions. The highest isothermal, 95°, appears in three regions, viz. in India, in Central Africa, and in North America. The summer isothermals are thrust further than anywhere else into higher latitudes in North America, from Mexico in a N.N.W. direction as far as the head waters of the Yukon. Over the whole of this region the climate is drier, and sunshine consequently stronger, than over the regions to the east and west of it. The isothermals occupy also higher positions in latitude over the Europeo-Asiatic continent, unless where the influence of sheets of water draws them into lower latitudes; and the remarkable parallelism of the lines in the more strictly inland climates is one of their most marked features. The influence of the ocean in maintaining a low temperature as compared with the land in the east of Asia from the Sea of Okotsk to China, and in the east of North America from Labrador to south of Cape Hatteras, is more pronounced than in any other of the warmer months of the year.

The almost equal lowering of the isothermals in the northern portion of the Pacific on each side of Behring Straits is very remarkable, and is in striking contrast to the totally different distribution of temperature which obtains in the same latitudes of the North Atlantic.

Mean temperatures under the freezing point are now wholly within the Arctic Circle.

The changes in the distribution of the pressure are a diminution over the whole of Asia, amounting to about two-tenths near the centre of the continent; all Europe, except the northern part of Scandinavia and Italy, Switzerland, the southern half of France, and the Peninsula; all North America, except the extreme south-east and the extreme north-west of the continent; and in the southern hemisphere, in New Zealand and the extreme south of Australia. Elsewhere pressure has risen, the greatest increase being in the Atlantic from Spain westward to long. 30°, and in the south of Africa. One of the most widespread changes in the distribution of pressure occurs from May to June, which ushers in the summer months of the northern hemisphere. It embraces nearly all the southern hemisphere, the Atlantic south of lat. 55° N., the increase flowing over so as to cover parts of Europe and North America.

The anticyclonic regions of high pressure are the four in the North and South

and had Challenger thermometers at the bottom. By this arrangement I hoped to get over the difficulty due to the temperature of the gun, by having the inner vessel enclosed in water which would be lowered in temperature to about 3° C. by the application of pressure. The device proved quite successful. The result of $1\frac{1}{2}$ tons pressure per square inch maintained for 20 minutes, some ice being still left in each vessel, was from a number of closely concordant trials—

Temperature in outer vessel, . . .	1°·7 C.
Temperature in inner vessel, . . .	0°·3 C.

The direct pressure correction for the thermometers is only about $-0°{\cdot}1$ C., and has therefore been neglected.

"The close agreement of this result with that obtained (under similar pressure conditions) in the thick glass vessel leaves no doubt that the lowering of the maximum-density point is somewhat under 4° C. for $1\frac{1}{2}$ tons, or 2°·7 C. for 1 ton per square inch. It is curious how closely this agrees with the result of my indirect experiments."

Further work of the same kind led me to the conclusion that even the double vessel had not sufficiently protected the contents from conducted heat, and to state in my Heat (p. 95, 1884) that "a pressure of 50 atmospheres lowers the maximum-density point by 1° C."

During the next two years I made several repetitions of these experiments, with the help of thermometers protected on the Challenger plan, but very much more sensitive. These experiments were not so satisfactory as those just described. The new thermometers caused a great deal of trouble by the uncertainty of their indications, which I finally traced to the fact that the paraffin oil which they contained passed, in small quantities, from one end of the mercury column to the other. I was occupied with an attempt to obtain more suitable instruments, when the arrival of the Amagat gauge turned my attention to other matters.

So far as I can judge from the results of the three different methods which I have employed, the lowering of the maximum-density point of water by 1 ton of pressure is very nearly, though perhaps a little in excess of, 3° C.

It is peculiarly interesting to find that Amagat, by yet another process,—viz. finding two temperatures not far apart at which water, at a given pressure, has the same volume,—has lately obtained a closely coinciding result. He says: "À 200 atm. (chiffres ronds) le maximum de densité de l'eau a rétrogradé vers zéro et l'a presque atteint; il parait situé entre zéro et 0°·5 (un demi-degré)."[1] This makes the effect of 1 ton slightly *less* than 3° C.

As the freezing point is lowered, according to J. Thomson's discovery, by about

[1] *Comptes Rendus*, tom. civ. p. 1160, 1887.

$1^\circ\cdot13$ only per ton of additional pressure,—and has a start of but 4°,—the maximum-density point will overtake it at about $-2^\circ\cdot4$, under a pressure of 2·14 tons.

The diagram 2 of Plate II. shows the consequences of the pressure-shifting of the maximum-density point in a very clear manner,—especially in its bearing on the expansibility of water at any one temperature but at different pressures. The curves in the diagram are for atmospheric pressure, and for additional pressures of 1, 2 and 3 tons respectively. They are traced roughly by the help of Despretz's tables of expansibility at atmospheric pressure, and the compression data of the present Report. The quantity of water taken in each case is that which, at 0° and under the particular pressure, has unit volume. Thus all the curves pass through the same point on the axis of volumes. How, in consequence of the gradual lowering of the maximum-density point, the expansibility at zero, which is negative at atmospheric pressure, and even at 1 ton of additional pressure, becomes positive and then rapidly greater as the pressure is raised, is seen at a glance.

I have to state, in conclusion, that my chief coadjutors in the experimental work have been Mr. H. N. Dickson and my mechanical assistant Mr. T. Lindsay. Mr. Dickson also reduced all the observations, about half of them having been done in duplicate by myself.

In the compression of glass I had the assistance of Mr. A. Nagel, and occasionally of Dr. Peddie.

Mr. A. C. Mitchell assisted me in the graphic work, and checked the calculations in the text.

I have already acknowledged the density determinations and analyses of sea-water and salt solutions made by Dr. Gibson.

And I have again been greatly indebted to the very skilful glass-working of Mr. Kemp.

[7/9/88.—The following analysis of the glass of my piezometers is given by Mr. T. F. Barbour, working in Dr. Crum Brown's Laboratory :—

SiO_2	=	61·20
PbO	=	20·94
$Al_2O_3 + Fe_2O_3$	=	0·82
CaO	=	2·20
MgO	=	0·26
K_2O	=	1·93
Na_2O	=	11·72.]

ADDENDUM (8/8/88).

The reader has already seen that I have, more than once in the course of the inquiry, found myself reproducing the results of others. A few days ago I showed the proof-sheets of this Report to Dr. H. du Bois, who happened to visit my laboratory, and was informed by him that one of Van der Waals' papers (he did not know which, but thought it was a recent one) contains an elaborate study of the molecular pressure in fluids. I had been under the impression, strongly forced on me by the reception which my speculations (Appendix E., below) met with both at home and abroad, that Laplace's views had gone entirely out of fashion;—having made, perhaps, their final appearance in Miller's *Hydrostatics*, where I first became acquainted with them about 1850. In Van der Waals' memoir "On the Continuity of the Gaseous and Liquid States," which I have just rapidly perused in a German translation, the author expresses himself somewhat to the following effect: If I here give values of K for some bodies, I do it not from the conviction that they are satisfactory, but because I think it important to make a commencement in a matter where our ignorance is so complete that not even a single opinion, based on probable grounds, has yet been expressed about it.

Van der Waals gives, as the value of K in water, 10,500 atmospheres; and, in a subsequent paper, 10,700 atm.; while the value given in the text above is about half, viz. 5480 atm. So far as I can see, he does not state how these values were obtained, though he gives the data and the calculations for other liquids. It is to be presumed, however, that his result for water was obtained, like those for ether and alcohol, from Cagniard de la Tour's data as to any two of the critical temperature, volume, and pressure. Van der Waals forms, by a very ingenious process, a general equation of the isothermals of a fluid, in which there are but two disposable constants. This is a cubic in v, whose three roots are real and equal at the critical point. Thus the critical temperature, volume, and pressure can all be expressed in terms of the two constants, so that one relation exists among them. Two being given, the equation of the isothermals can be formed, and from it K can be at once found.

My process, as explained above, was very different. I formed the equation of the isothermal of water at 0° C. from the empirical formula for the average compressibility under large additional pressures; and by comparing this, and the corresponding equation for various salt solutions, with an elementary formula of the Kinetic theory of gases, I was led to interpret, as the internal pressure, a numerical quantity which appears in the equations.

I have left the passages, in the text and Appendix alike, which refer to this subject in the form in which they stood before I became acquainted with Van der Waals' work. I have not sufficiently studied his memoir to be able as yet to form a definite opinion whether the difficulty (connected with the non-hydrostatic nature of the pressure in surface films) which is raised in Appendix E. can, or cannot, be satisfactorily met by Van der Waals' methods. Anyhow, the isothermals spoken of in that Appendix are totally different from those given by Van der Waals' equation, inasmuch as the whole pressure, and not merely the external pressure, is introduced graphically in my proposed construction.

SUMMARY OF RESULTS.

It is explained in the preceding pages that the pressures employed in the experiments ranged from 150 to 450 atm., so that results given below for higher or lower pressures [and enclosed in square brackets] are extrapolated. A similar remark applies to temperature, the range experimentally treated for water and for sea-water being only 0° to 15° C. Also it has been stated that the recording indices are liable to be washed down the tube, to a small extent, during the relief of pressure, so that the results given are probably a little too *small*.

Compressibility of Mercury, per atmosphere, . . .	0·0000036
,, ,, Glass, ...	0·0000026

Average compressibility of fresh water :—

[At low pressures	$520.10^{-7}-355.10^{-9}t+3.10^{-9}t^2$]		
For 1 ton = 152·3 atm.	504	360	4
2 ,, = 304·6 ,,	490	365	5
3 ,, = 456·9 ,,	478	370	6

The term independent of t (the compressibility at 0° C.) is of the form

$$10^{-7}\,(520-17p+p^2),$$

where the unit of p is 152·3 atm. (one ton-weight per sq. in.). This must not be extended in application much beyond $p=3$, for there is no warrant, experimental or other, for the minimum which it would give at $p=8{\cdot}5$.

The point of minimum compressibility of fresh water is probably about 60° C. at atmospheric pressure, but is lowered by increase of pressure.

As an *approximation* through the whole range of the experiments we have the formula :—

$$\frac{0{\cdot}00186}{36+p}\left(1-\frac{3t}{400}+\frac{t^2}{10{,}000}\right);$$

while the following formula exactly represents the average of all the experimental results at each temperature and pressure :—

$$10^{-7}\,(520-17p+p^2)-10^{-9}\,(355+5p)\,t+10^{-9}\,(3+p)\,t^2.$$

Average compressibility of sea-water (about 0·92 of that of fresh water) :—

[At low pressures	$481.10^{-7}-340.10^{-9}t+3.10^{-9}t^2$]		
For 1 ton	462	320	4
2 ,,	447·5	305	5
3 ,,	437·5	295	5

Term independent of t :—

$$10^{-7}\,(481 - 21{\cdot}25p + 2{\cdot}25p^2)$$

Approximate formula :—

$$\frac{0{\cdot}00179}{38+p}\left(1 - \frac{t}{150} + \frac{t^2}{10{,}000}\right)$$

Minimum compressibility point, probably about 56° C. at atmospheric pressure, is lowered by increase of pressure.

Average compressibility of solutions of NaCl for the first p tons of additional pressure, at 0° C. :—

$$\frac{0{\cdot}00186}{36 + p + s}$$

where s of NaCl is dissolved in 100 of water.

Note the remarkable resemblance between this and the formula for the average compressibility of fresh water at 0° C. and $p + s$ tons of additional pressure.

[Various parts of the investigation seem to favour Laplace's view that there is a large molecular pressure in liquids. In the text it has been suggested, in accordance with a formula of the Kinetic Theory of Gases, that in water this may amount to about 36 tons-weight on the square inch. In a similar way it would appear that the molecular pressure in salt solutions is greater than that in water by an amount directly proportional to the quantity of salt added.]

Six miles of sea, at 10° C. throughout, are reduced in depth 620 feet by compression. At 0° C. the amount would be about 663 feet, or a furlong. (This quantity varies nearly as the square of the depth.) Hence the pressure at a depth of 6 miles is nearly 1000 atmospheres.

The maximum-density point of water is lowered about 3° C. by 150 atm. of additional pressure.

From the heat developed by compression of water I obtained a lowering of 3° C. per ton-weight per square inch.

From the ratio of the volumes of water (under atmospheric pressure) at 0° C. and 4° C., given by Despretz, combined with my results as to the compressibility, I found 3°·17 C.:—and by direct experiment (a modified form of that of Hope) 2°·7 C. The circumstances of this experiment make it certain that the last result is too small.

Thus, at ordinary temperatures, the expansibility of water is increased by the application of pressure.

In consequence, the heat developed by sudden compression of water at temperatures above 4° C. increases in a higher ratio than the pressure applied; and water under 4° C. may be heated by the sudden application of sufficient pressure.

The maximum density coincides with the freezing-point at −2°·4 C., under a pressure of 2·14 tons.

APPENDIX A.

ON AN IMPROVED METHOD OF MEASURING COMPRESSIBILITY.

"WHEN the compressibility of a liquid or gas is measured at very high pressures, the compression vessel has to be enclosed in a strong cylinder of metal, and thus it must be made, in some way, self-registering. I first used indices, prevented from slipping by means of hairs. Sir W. Thomson's devices for sounding, at small depths, by the compression of air, in which he used various physical and chemical processes for recording purposes, led me to devise and employ a thin silver film which was washed off by a column of mercury. Much of my work connected with the Challenger Thermometers was done by the help of this process. Till quite recently I was unaware that it had been devised and employed by Cailletet in 1873, only that his films were of gold.

"But the use of all these methods is very laborious, for the whole apparatus has to be opened *for each individual reading*. Hence it struck me that, instead of measuring the compression produced by a given pressure, we should try to measure the pressure required to produce a given compression. I saw that this could be at once effected by the simplest electric methods; *provided that glass, into which a fine platinum wire is fused, were capable of resisting very high pressures without cracking or leaking at the junctions*. This, on trial, was found to be the case.

"We have, therefore, only to fuse a number of platinum wires, at intervals, into the compression tube, and very carefully calibrate it with a column of mercury which is brought into contact with each of the wires successively. Then if thin wires, each resisting say about an ohm, be interposed between the pairs of successive platinum wires, we have a series whose resistance is diminished by one ohm each time the mercury, forced in by the pump, comes in contact with another of the wires. Connect the mercury with one pole of a cell, the highest of the platinum wires with the other, leading the wires out between two stout leather washers; interpose a galvanometer in the circuit, and the arrangement is complete. The observer himself works the pump, keeping an eye on the pressure gauge, and on the spot of light reflected by the mirror of the galvanometer. The moment he sees a change of deflection he reads

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 2, 3, 1884.

the gauge. It is convenient that the external apparatus should be made to leak slightly; for thus a *series* of measures may be made, in a minute or two, for the contact with each of the platinum wires. Then we pass to the next in succession."

M. Amagat[1] remarks on the use of this method as follows:—"Le liquide du piézomètre, et le liquide transmettant la pression dans lequel il est plongé (glycérine), s'échauffent considérablement par la pression; cette circonstance rend les expériences très longues: il faut un temps considérable pour équilibrer la masse qui est peu conductrice; il faut répéter les lectures jusqu'à ce que l'indication du manomètre devienne constante au moment du contact. Les séries faites par pressions décroissantes produisent le même effet en sens inverse; on prend la moyenne des résultats, dont la concordance montre que l'ensemble de la méthode ne laisse réellement presque rien à désirer.

"On voit par là quelles grossières erreurs ont pu être commises avec les autres artifices employés jusqu'ici pour la mesure des volumes dans des conditions analogues."

It must be remembered that M. Amagat is speaking of experiments in which pressures rising to 3000 atmospheres were employed.

[1] *Comptes Rendus*, tom. ciii. p. 431, 1886.

APPENDIX B.

RELATION BETWEEN TRUE AND AVERAGE COMPRESSIBILITY.

THE average compressibility per ton for the first p tons of additional pressure is

$$\frac{v_0 - v}{pv_0};$$

where v_0 is the initial volume, and v is the volume at p additional tons.

The true compressibility at p additional tons is

$$-\frac{dv}{vdp}.$$

Hence, if one of these quantities is given as a function of p, it may be desirable to find the corresponding expression for the other. The simplest example, that on p. 30, will suffice to show the principle of the calculation. Let

$$\frac{v_0 - v}{pv_0} = e\,(1 - fp)\,; \quad . \ . \ . \ . \ (1)$$

where e is, in general, a much smaller quantity than f. We have

$$\frac{v}{v_0} = 1 - ep + efp^2,$$

whence

$$-\frac{dv}{vdp} = \frac{e\,(1 - 2fp)}{1 - ep + efp^2} = e\,(1 - (2f - e)\,p + \ . \ . \ .) \quad . \ . \ . \ . \ (2)$$

where the expansion may be easily carried further if required.

If the terms in the second and higher powers of p are to be neglected, (1) and (2) as written show at once how to convert from true to average compressibility, or *vice versâ*.

APPENDIX C.

CALCULATION OF LOG. FACTORS.

LET W be the weight of mercury which would take the place of the liquid in the piezometer, w that of the mercury which fills a length l of the stem. Then a compression read as x on the stem is

$$\frac{x}{l}\frac{w}{W}$$

This assumes the stem to be uniform; in general it must be corrected from the results of the calibration :—unless, as in the example given on p. 16 of the text, l be chosen very nearly equal to x, as found by trial for each value of the pressure.

Also if y be the reading of the gauge, and if a on the gauge correspond to an atmosphere, the pressure is

$$\frac{y}{a} \text{ atm.}$$

Hence the average apparent compressibility per atmosphere is

$$\frac{x}{y} \cdot \frac{wa}{lW}$$

Its logarithm is

$$\log. x - \log. y + (\log. w - \log. W - \log. l) + \log. a.$$

The last four terms, of which log. a is the "gauge log.," form the log. factor as given in the text

APPENDIX D.

NOTE ON THE CORRECTION FOR THE COMPRESSIBILITY OF THE PIEZOMETER.

THE usual correction neglects the fact that when the compressibility of the liquid is different from that of the walls, the liquid under pressure does not occupy the *same part* of the vessel as before pressure.

Let V be the volume of the part of the vessel occupied by liquid; a that of the tube between the two positions of the index, both measured at 1 atmosphere; e, ϵ, the average absolute compressibility of liquid and vessel per ton for the first p additional tons. Equate to one another the volume of the liquid, and the volume of the part of the vessel into which it is forced, both at additional pressure p. We have thus—

$$\mathrm{V}(1 - ep) = (\mathrm{V} - a)(1 - \epsilon p)$$

whence

$$e = \epsilon\left(1 - \frac{a}{\mathrm{V}}\right) + \frac{a}{p\mathrm{V}}$$

As $\frac{a}{\mathrm{V}}$ is usually small, this equation is treated as equivalent to

$$e = \epsilon + \frac{a}{p\mathrm{V}}$$

i.e., the absolute compressibility of the liquid is equal to its apparent compressibility, added to the absolute compressibility of the envelop.

One curious consequence of the exact equation is that, if the compressibilities were both constant, or were known to change in a given ratio by pressure, it would be possible (theoretically at least) to measure absolute compressibilities by piezometer experiments alone, without employing a substance whose absolute compressibility is determined by an independent process. For the additional term in the exact equation makes the cöefficients of e and ϵ numerically different; whereas in the approximate equation they are equal, but with opposite signs, and therefore can give $e - \epsilon$ only.

In my experiments described above, a/V rarely exceeds 0·02, so that this correction amounts to (0·02 × 26 in 500, or) 5 units in the fourth significant place; and thus *just* escapes having to be taken account of. When 4 places are sought at lower pressures than 3 tons, or 3 places at pressures of 4 tons and upwards, it must be taken account of.

APPENDIX E.

ON THE RELATIONS BETWEEN LIQUID AND VAPOUR.

In connection with the present research a number of side issues have presented themselves, some of which come fairly within the scope of the Report. I commence by reprinting two Notes, read on January 19 and February 2, 1885, to the Royal Society of Edinburgh:[1]—

ON THE NECESSITY FOR A CONDENSATION-NUCLEUS.

"The magnificent researches of Andrews on the isothermals of carbonic acid formed, as it were, a nucleus in a supersaturated solution, round which an immediate crystallization started, and has since been rapidly increasing.

"They gave the clue to the explanation of the paradoxical result of Regnault, that hydrogen is less compressible and other gases more compressible, under moderate pressure, than Boyle's Law indicates; and to that of the companion result of Natterer that, at very high pressures, all gases are less compressible than that law requires. Thus they furnished the materials for an immense step in connection with the behaviour of fluids *above* their critical points.

"But they threw at least an equal amount of light on the liquid-vapour question, *i.e.* the behaviour of fluids at temperatures *under* their critical points. In Andrews' experiments there was a commencement, and a completion, of liquefaction; each at a common definite pressure, but of course at very different volumes, for each particular temperature.

"In 1871 Professor J. Thomson communicated to the Royal Society a remarkable paper on the *abrupt* change from vapour to liquid, or the opposite, indicated by these experiments. He called special attention to the necessity for a 'start,' as it were, in order that these changes might be effected. [It is to this point that the present Note is mainly directed, but I go on with a brief analysis of Thomson's work.] He pointed out that there were numerous experiments proving that water could be heated, under certain conditions, far above its boiling point without evaporating; and that, probably,

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 78 and 91, 1885.

steam might be condensed isothermally to supersaturation without condensing. Hence he was led to suggest an isothermal of continued curvature, instead of the broken line given by Andrews, as representing the *continuous* passage of a fluid from the state of vapour to that of liquid; the whole mass being supposed to be, at each stage of the process, in the same molecular state.

"In Clerk-Maxwell's 'Treatise on Heat,' this idea of J. Thomson's was developed, in connection with a remarkable speculation of W. Thomson,[1] on the pressure of vapour as depending on the curvature of the liquid surface in contact with it. This completely accounts for the deposition of vapour when a proper nucleus is present. Maxwell showed that it could also account for the 'singing' of a kettle, and for the growth of the larger drops in a cloud at the expense of the smaller ones.

"The main objection to J. Thomson's suggested isothermal curve of transition is that, as Maxwell points out, it contains a region in which pressure and volume increase or diminish simultaneously. This necessarily involves instability, inasmuch as, for definite values of pressure at constant temperature within a certain range in which vapour and liquid can be in equilibrium, Thomson's hypothesis leads to three different values of volume: two of which are stable; but the intermediate one essentially unstable. According to Maxwell, the extremities of this triple region correspond to pressures, at which, regarded from the view of steady increase or diminution of pressures, either the vapour condenses suddenly into liquid, or the liquid suddenly bursts into vapour.

"If this were the case, no nucleus would be *absolutely* requisite for the formation either of liquid from vapour or of vapour from liquid. All that would be required, in either case, would be the proper increase or diminution of pressure;—temperature being kept unaltered. The latent heat of vapour, which we know to become less as the critical point is gradually arrived at, would thus be given off in the explosive passage from vapour to liquid. It is difficult to see, on this theory, how it can be explosively taken in on the sudden passage from liquid to vapour.

"Aitken's experiments tend to show, what J. Thomson only speculatively announced, that possibly vapour may not be condensed (in the absence of a nucleus), when compressed isothermally, even at ranges far beyond the *maximum* of pressure indicated in Thomson's figures. Hence it would appear that the range of instability is much less than that given by Thomson's figures, and may (perhaps) be looked on as a vanishing quantity; the corresponding part of the isothermal being a finite line parallel to the axis of pressures, corresponding to the sudden absorption or giving out of latent heat."

[1] *Proc. Roy Soc. Edin.*, vol. vii. p. 63, 1870.

ON EVAPORATION AND CONDENSATION.

"While I was communicating my Note on the *Necessity for a Condensation Nucleus* at the last meeting of the Society, an idea occurred to me which germinated (on my way home) to such an extent that I sent it off by letter to Professor J. Thomson that same night.

"J. Thomson's idea, which I had been discussing, was to preserve, if possible, physical (as well as geometrical) *continuity* in the isothermal of the liquid-vapour state, by keeping the *whole* mass of fluid in one state throughout. He secured geometrical, but not physical, continuity. For, as Clerk-Maxwell showed, one part of his curve makes pressure and volume increase simultaneously, a condition essentially unstable. The idea which occurred to me was, while preserving geometrical continuity, to get rid of the region of physical instability, *not* (as I had suggested in my former Note) by retaining Thomson's proposed finite maximum and minimum of pressure in the isothermal, while bringing them infinitely close together so far as volume is concerned, and thus restricting the unstable part of the isothermal to a finite line parallel to the pressure axis; but, *by making both the maximum and minimum infinite*. Geometrical continuity, of course, exists across an asymptote parallel to the axis of pressures; so that, from this point of view, there is nothing to object to. On the other hand, there is essentially physical discontinuity, in the form of an impassable barrier between the vaporous and liquid states, so long at least as the substance is considered as homogeneous throughout.

"It appeared to me that here lies the true solution of the difficulty. As we are dealing with a fluid mass essentially homogeneous throughout, it is clear that we are not concerned with cases in which there is a molecular surface-film.

"Suppose, then, a fluid mass, somehow maintained at a constant temperature (lower than its critical point), and so extensive that its boundaries may be regarded as everywhere infinitely distant, what will be the form of its isothermal in terms of pressure and volume?

"Two prominent experimental facts help us to an answer.

"*First.* We know that the interior of a mass of liquid mercury can be subjected to hydrostatic *tension* of considerable amount without rupture. The isothermal must, in this case, *cross* the line of volumes; and the limit of the tension would, in ordinary language, be called the cohesion of the liquid. I am not aware that this result has been obtained with water free from air; but possibly the experiment has not been satisfactorily made. The common experiment in which a rough measure is obtained of the force necessary to tear a glass plate from the surface of water is vitiated by the instability of the concave molecular film formed.

"*Second.* Aitken has asserted, as a conclusion from the results of direct experiment, that even immensely supersaturated aqueous vapour will not condense without the presence of a nucleus. This may be a solid body of finite size, a drop of water, or fine dust particles.

"Both of these facts fit perfectly in to the hypothesis, that the isothermal in question has an asymptote parallel to the axis of pressure; the vapour requiring (in the absence of a nucleus) practically infinite pressure to reduce it, without change of state or of temperature, to a certain finite volume; while the liquid, also without change of state or temperature, may by sufficient hydrostatic *tension* be made to expand almost to the same limit of volume.

"This limiting volume depends, of course, on the temperature of the isothermal; rising with it up to the critical point.

"The physical, not geometrical, discontinuity is of course to be attributed to the latent heat of vaporisation. The study of the adiabatics, as modified by this hypothesis, gives rise to some curious results.

"It is clear that the experimental realisation of the parts of the here suggested curve near to the asymptote, on either side, will be a matter of great difficulty for any substance. But valuable information may perhaps be obtained from the indications of a sensitive thermo-electric junction immersed in mercury at the top of a column which does not descend in a barometer tube of considerably more than 30 inches long, when the tube is suddenly placed at a large angle with the vertical; or from those of a similar junction immersed in water, when it has a concave surface of great curvature from which the atmospheric pressure is removed.

"Nothing of what is said above will necessarily apply when we have vapour and liquid in presence of one another, or when we consider a small portion of either in the immediate neighbourhood of another body. For then we are dealing with a state of stress which cannot, like hydrostatic pressure or tension, be characterized (so far as we know) by a single number. The stress in these molecular films is probably one of tension in all directions parallel to the film, and of pressure in a direction perpendicular to it. Thus it is impossible to represent such a state properly on the ordinary indicator diagram. This question is still further complicated by the possibility that the difference between the internal pressures, in a liquid and its vapour in thermal equilibrium, may be a very large quantity."

As soon as I heard of Berthelot's experiment, I had it successfully repeated in my laboratory; and I considered that it afforded very strong confirmation of the hypothesis advanced in the last preceding extract.

But since I have been led to believe that there is probably truth in Laplace's statement as to the very great molecular pressure in liquids, I have still further modified the speculation. I now propose to take away the new asymptote, and make

the two branches of the isothermal join one another by what is practically a part of that asymptote:—thus making the liquid and the vaporous stages continuous with one another by means of a portion very nearly straight and parallel to the pressure axis. Somewhere on this will be found one of the points of inflection of the isothermal, the other being at a somewhat smaller volume, and at a pressure which is moderate for temperatures close to, but under, the "critical point," but commences to increase with immense rapidity as the temperature of the isothermal is lowered. *All* the isothermals will now present the same general features, dependent on the existence of two asymptotes and two points of inflection, whether they be above or below the critical point; but their form will be modified in different senses above and below it. The portion of the curve which is convex upwards will be nearly horizontal at the critical point, and will become steeper both above and below it; but pressure and volume will nowhere increase together. This suggestion, of course, like that in the second extract above, is essentially confined to the case of a fluid mass which is supposed to have no boundaries; for their introduction at once raises the complex difficulties connected with the surface-skin. Thus it will be seen that the conviction that water has large molecular pressure has led me back to what is very nearly the first of the two hypotheses I proposed.

A practical application of some of the principles just discussed is described in the following little paper:—

ON AN APPLICATION OF THE ATMOMETER.[1]

"The Atmometer is merely a hollow ball of unglazed clay, to which a glass tube is luted. The whole is filled with boiled water, and inverted so that the open end of the tube stands in a dish of mercury. The water evaporates from the outer surface of the clay (at a rate depending partly on the temperature, partly on the dryness of the air), and in consequence the mercury rises in the tube. In recent experiments this rise of mercury has been carried to nearly 25 inches during dry weather. But it can be carried much farther by artificially drying the air round the bulb. The curvature of the capillary surfaces in the pores of the clay, which supports such a column of mercury, must be somewhere about 14,000 (the unit being an inch). These surfaces are therefore, according to the curious result of Sir W. Thomson (Proc. Roy. Soc. Edin., p. 63, 1870), specially fitted to absorb moisture. And I found, by inverting over the bulb of the instrument a large beaker lined with moist filter-paper, that the arrangement can be made extremely sensitive. The mercury surface is seen to become flattened the moment the beaker is applied, and a few minutes suffice to give a large descent, provided the section of the tube be small, compared with the surface of the ball.

[1] *Proc. Roy. Soc. Edin.*, vol. xiii. pp. 116, 117, 1885

"I propose to employ the instrument in this peculiarly sensitive state for the purpose of estimating the amount of moisture in the air, when there is considerable humidity; but in its old form when the air is very dry. For this purpose the end of the tube of the atmometer is to be connected, by a flexible tube, with a cylindrical glass vessel, both containing mercury. When a determination is to be made in moist air, the cylindrical vessel is to be lowered till the difference of levels of the mercury amounts to (say) 25 inches, and the diminution of this difference in a definite time is to be carefully measured, the atmospheric temperature being observed. On the other hand, if the air be dry, the difference of levels is to be made *nil*, or even negative, at starting, in order to promote evaporation. From these data, along with the constant of the instrument (which must be determined for each clay ball by special experiments), the amount of vapour in the air is readily calculated. Other modes of observation with this instrument readily suggest themselves, and trials, such as it is proposed to make at the Ben Nevis Observatory during summer, can alone decide which should be preferred."

APPENDIX F.

THE MOLECULAR PRESSURE IN A LIQUID.

LAPLACE's result, so far as concerns the question raised in the text, may be stated thus. If $MM'\phi(r)$ be the molecular force between masses M, M′ of the liquid, at distance r, the whole attraction on unit mass, at a distance x within the surface, is

$$X = 2\pi\rho\int_x^\infty r dr \int_r^\infty \phi(r) dr,$$

where ρ is the density of the liquid. The density is supposed constant, even in the surface-skin. As we are not concerned with what are commonly called capillary forces, the surface is supposed to be plane.

The pressure, p, is found from the ordinary hydrostatic equation

$$\frac{dp}{dx} = \rho X.$$

Hence the pressure in the interior of the liquid is

$$K = \rho\int_0^\alpha X dx,$$

where α is the limit at which the molecular force ceases to be sensible.

But the expression for K is numerically the work required to carry unit volume of the liquid from the interior, through the skin, to the surface. It is easy to see that the further work, required to carry it wholly out of the range of the molecular forces, has precisely the same value. Thus the whole work required to carry, particle by particle, a cubic inch of the liquid from the interior to a finite distance from its surface is

$$2K \times 1 \text{ cub. in.}$$

This investigation assumes ρ to be constant throughout the liquid, and thus ignores the (almost certain) changes of density in the various layers of the surface-skin; so that its conclusions, even when the question is regarded as a purely statical one, are necessarily subject to serious modification. With our present knowledge of the nature of heat, we cannot regard this mode of treatment as in any sense satisfactory.

APPENDIX G.

EQUILIBRIUM OF A COLUMN OF WATER.

FIRST, suppose the temperature to be the same throughout. Let a be the whole depth, ρ_0 the density, on the supposition that gravity does not act. Then, if ρ be the density at the distance ξ from the bottom, when gravity acts, we have by the hydrostatic equation

$$\frac{dp}{d\xi} = -g\rho = -g\rho_0 \frac{1}{1 - \dfrac{\mathrm{A}p}{\Pi + p}}$$

if we adopt the rough formula of Section VII. for the compressibility. The integral is

$$p(1-\mathrm{A}) + \mathrm{A}\Pi \log.(\Pi + p) = \mathrm{C} - g\rho_0\xi.$$

Now the conditions are—

$$(1)\ \xi = \xi_0 \text{ (the altered depth)}, p = 0;$$

$$(2)\ \xi = 0,\ p = g\rho_0 a = \varpi \text{ suppose.}$$

So that

$$\xi_0 = a(1-\mathrm{A}) + \frac{\mathrm{A}\Pi}{g\rho_0} \log. \frac{\Pi + g\rho_0 a}{\Pi}$$

$$= a(1-\mathrm{A}) + \frac{\mathrm{A}\Pi a}{\varpi} \log. \left(1 + \frac{\varpi}{\Pi}\right)$$

Since, even in the deepest sea, ϖ/Π is not greater than 1/6, we may expand the logarithm in ascending powers of this fraction. We thus obtain

$$\xi_0 = a - a\mathrm{A}\left\{1 - \frac{\Pi}{\varpi}\left(\frac{\varpi}{\Pi} - \frac{\varpi^2}{2\Pi^2} + \frac{\varpi^3}{3\Pi^3} - \ldots\right)\right\}$$

$$= a - a\mathrm{A}\left\{\frac{\varpi}{2\Pi} - \frac{\varpi^2}{3\Pi^2} + \ldots\right\}$$

The second term is the diminution of depth required. We may write it, with change of sign, as

$$\frac{\mathrm{A}}{2\Pi} g\rho_0 a^2 \left(1 - \frac{2\varpi}{3\Pi} + \frac{\varpi^2}{2\Pi^2} - \&c.\right)$$

As the factor A/Π stands for what is called e in the text, the first term is the

result given in the text; and the others show how it is modified by taking account of the diminished compressibility at the higher pressures.

Of course we might have employed the more exact formulæ, (A) or (B) as the case may be, but for all practical applications the rough formula suffices.

It might be interesting to study the effect on the mean level of a lake due to the indirect as well as the direct results of change of temperature. Heating of the water throughout, if there be a case of the kind, would increase the depth not only in consequence of expansion (provided the temperature were nowhere under the maximum density point), but also in consequence of the diminution of compressibility which it produces. Thus there would be an efficient cause of variation of depth with the seasons, altogether independent of the ordinary questions of supply from various sources and loss by evaporation.

If the temperature be not constant for all depths, ρ_0, ρ, and A are functions of ξ. Substituting their values in the hydrostatic equation, we must integrate it and determine the constant by the same conditions as before.

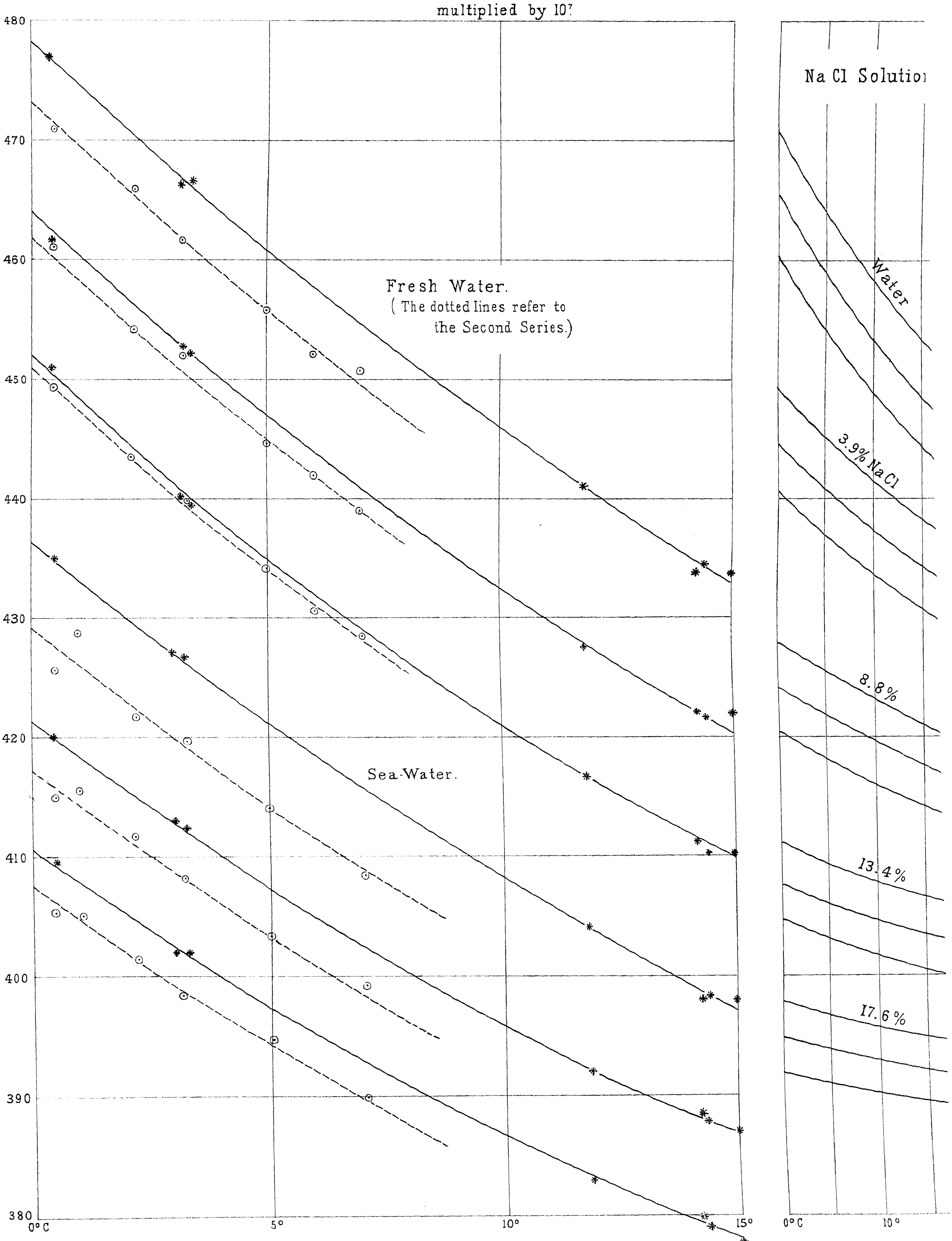
The condition for stable equilibrium is merely that $d\rho/d\xi$ shall not be anywhere positive. Until some definite problem is proposed, no more can be done with the equation.

[29/10/88.—At Dr. Murray's request I have calculated, from the data given in his paper: On the Height of the Land, and the Depth of the Ocean (Scottish Geographical Magazine, vol. iv. pp. 1–41, 1888), that the whole depression of the ocean level, due to compression, is about

116 feet only.

If water ceased to be compressible, the effect would be to submerge some 2,000,000 square miles of land, about 4 per cent. of the whole.]

AVERAGE APPARENT COMPRESSIBILITIES for 1, 2, & 3 TONS, multiplied by 10^7



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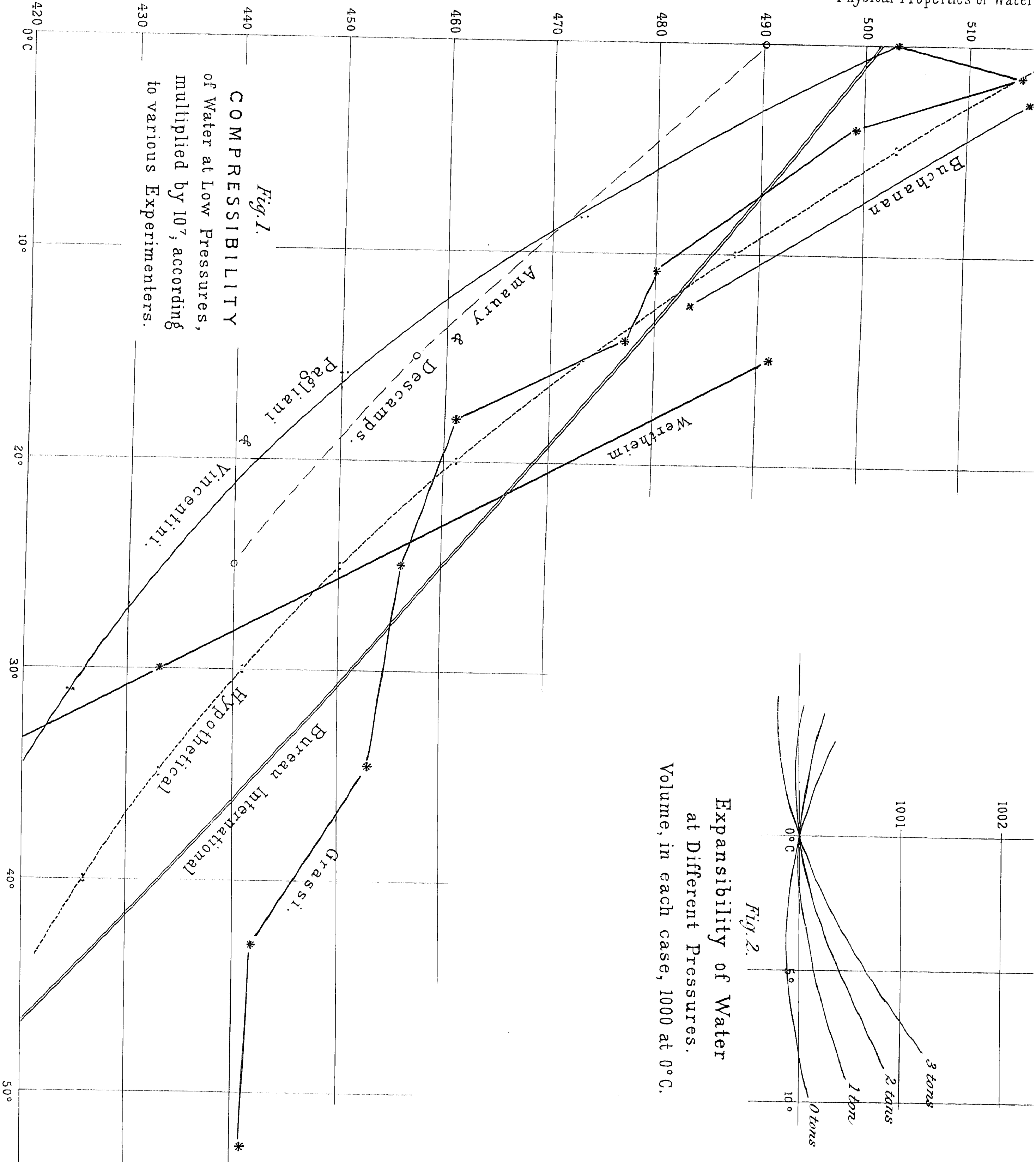
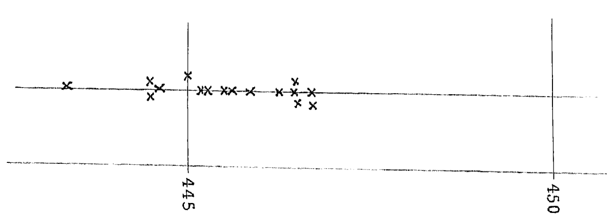


Observations of Apparent Average Compressibility of Water for 305 Atmospheres at 5° C, multiplied by 10^7. 29 & 30/12/87.



THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on ATMOSPHERIC CIRCULATION based on the Observations made on board H.M.S. Challenger during the years 1873-1876, and other Meteorological Observations. By ALEXANDER BUCHAN, M.A., LL.D., Secretary of the Scottish Meteorological Society.

IN the Narrative of the Cruise of the Challenger, vol. ii. pp. 300 to 304, the conditions are detailed under which the meteorological observations were made during the voyage, and the observations themselves are printed *in extenso*, pp. 305 to 744.

The instruments employed, which had been previously verified, were furnished by the Meteorological Department of the Board of Trade. The observations were uniformly made at two-hourly intervals, except when the Challenger was in Sub-Antarctic waters, from December 21st, 1873, to March 17th, 1874, the observations being then made every hour.

TEMPERATURE.—The dry and wet bulb thermometers were, in the early part of the voyage, suspended in the small screen provided by the Meteorological Department, which was fastened to the after upright of the steering wheel, under the pilotage bridge; but as this screen was too small to contain a maximum and minimum thermometer in addition to the dry and wet bulbs, a larger one was con-

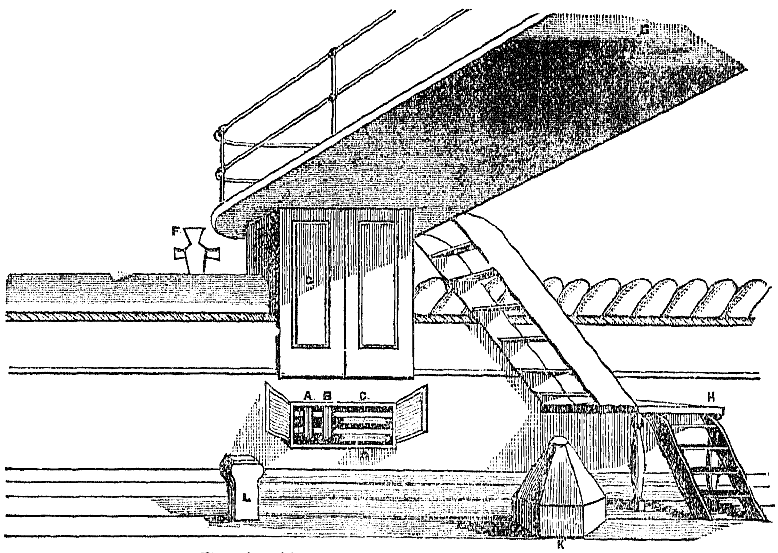


FIG. 1.—Showing position of Thermometers.

A, dry bulb thermometer; B, wet bulb thermometer; C, maximum thermometer; D, minimum thermometer; E, pilotage bridge; F, bollard for boat's fall; G, signal locker; H, platform and ladders leading to bridge; K, skylight over naturalists' workroom; L, towing bollard.

structed and placed against the ship's side, under the shade of the pilotage bridge, as represented in Fig. 1 supplied by Staff-Commander Tizard, R.N. The change was effected on April 17th, 1873, the thermometers being separated from the ship's side by wooden battens about three inches in thickness, and the maximum and minimum thermometers were hung from the same battens. The thermometers were occasionally tested for error of zero points, in melting ice, and further with a standard thermometer by Geisler.

The relative humidity was deduced from the dry and wet bulb readings by Glaisher's Hygrometrical Tables, sixth edition.

The temperature of the surface of the sea was obtained by drawing a bucket of water from over the side of the ship, and immersing a thermometer in it, care being taken that the water was obtained from a position sufficiently far forward to be clear of the discharge-pipes from the engines, etc. When in the region of ocean stream currents, the temperature of the surface water was taken at hourly or half-hourly intervals.

Atmospheric Pressure.—The barometer was suspended on the main deck, just outside the captain's cabin, the cistern being $9\frac{1}{2}$ feet above the level of the sea. The same barometer, which was used throughout, was compared with the standard at Kew before leaving and again on the return to England, and also with the barometers in the Observatories at the Cape of Good Hope, and at Sydney, N.S.W., its error remaining constant throughout the voyage. The readings have been corrected for all instrumental errors, and reduced to 32° and sea level. No correction for errors of observation were made in the observations printed in the "Narrative," but in this discussion of the results all evident errors of observation have been rectified.

Wind and Weather.—In accordance with the practice on board ship, the compass direction of the wind was recorded at the time of observation, but in the printed table its direction has been referred to the true meridian. In describing the force of the wind and state of the weather, the notation proposed by Admiral Beaufort was employed. This notation is explained in all elementary works on meteorology.

Clouds.—The amount recorded was in all cases estimated, 10 indicating a sky completely overcast and 0 a clear sky. Both the upper and lower clouds were recorded, and the notation of the species was that generally in use, being essentially Howard's classification.

Currents.—The direction and rate of the current was derived from the differences in the position of the ship at noon determined by astronomical observation and that determined by courses steered and distances run by patent log from the astronomical position of the preceding noon. Specific observations on the direction and rate of the surface currents were frequently made during the voyage, either from a boat fast to the trawl rope, or when the ship was kept stationary for sounding purposes, occasionally by comparing the distances shown by patent log with the distances made good over the

ground as ascertained by objects on shore. These several results, independent of the ship reckoning, are given in the account of the voyage. It has been disputed whether the difference in a day's run between the position of the ship by dead reckoning and by astronomical observation can be regarded as giving with sufficient accuracy the movement of the surface water. But the long experience of navigators proves that with due care this result furnishes a fair approximation to the truth, and especially so when the astronomical observations are made at frequent intervals during the twenty-four hours. Much care was taken during the voyage, by due attention to the steerage and estimation of the leeway, to keep an accurate reckoning, and also to ascertain frequently the latitude and longitude by astronomical observation. The surface set deduced by these means was found in the majority of cases to be continuous during the day, and to agree in a striking manner with the surface current, as found by anchoring a boat, or other direct method.

SPECIFIC GRAVITY OF SEA WATER.—The specific gravity of the sea water during the voyage was ascertained by Mr. Buchanan, the analytical chemist of the Expedition, with a delicate hydrometer, designed by him for this purpose, which is described in Physics and Chemistry, vol. i.

The most cursory glance suffices to show that the varying phenomena with which meteorology deals are all referable to the sun, it being evident that if the sun were blotted out from the sky, a cold lifeless uniformity would take possession of the whole surface of the earth. It is thus that all meteorological phenomena may be conveniently grouped into two great classes: those resulting from the revolution of the earth on its axis, and those resulting from its revolution round the sun taken in connection with the inclination of its axis to the plane of its orbit. Hence meteorology falls into two great divisions, the first embracing diurnal and the second annual phenomena.

Humboldt, Dove, Kuppfer, Quetelet, Sabine, Brewster, and the other early founders of the science, were keenly alive to the essential importance of hourly observations in the investigation of diurnal phenomena. By the influence they brought to bear on the Governments of the day, meteorological and magnetical Observatories of the first class were established widely over the civilised world, from which observational data were obtained that will always hold their place as contributions of the first importance to science.

On the basis of these observations the diurnal changes in atmospheric pressure, temperature, humidity, and wind were partially revealed and explained. It came, however, by and by to be felt that data supplied exclusively by Observatories on land were inadequate to a right conception and explanation of meteorological phenomena, and accordingly when the Challenger Expedition was fitted out, arrangements were made for taking, during the cruise, either hourly or two-hourly meteorological observa-

tions. These observations are by far the most complete yet made on the meteorology of the ocean.

In discussing the observations, the first step was to recopy the whole of them, arranged chronologically as observed, according to the hours of observation, a distinct set thus arranged being set apart for each of the subjects observed, viz. the barometer, dry bulb, wet bulb, maximum and minimum thermometers, wind, cloud, weather, squalls, thunder and lightning, and the temperature of the surface of the sea. The hourly values were then calculated for periods of time varying from three days to a month, and from these results hourly values for still longer periods were calculated, with the view of showing the distribution of the phenomena, as influenced by proximity to, or distance from, land, by latitude, by season, and in some cases by the extent of water surface presented by the five great oceans of the globe.

Diurnal Phenomena.

Variation of Temperature. — Of the daily changes which take place in the atmosphere, the first place must be assigned to those which relate to temperature, since on these changes all others are either directly or indirectly dependent. Observations of the temperature of the air, and of the water and land surfaces of the earth, are thus of fundamental importance in meteorology.

The sun's rays which fall on land and on solid bodies generally are wholly absorbed by the thin surface layer exposed to the heating rays, the temperature of which consequently rises. While the temperature of the surface thus increases, a wave of heat is propagated downwards through the soil. The intensity of this daily wave of temperature rapidly diminishes with the depth, so that it ceases to be measurable about four feet below the surface. Part of the heat thus imparted to the surface layers is conveyed away upwards by convection currents, which originate in the superheating of the lowermost stratum of air in direct contact with the heated surface of the land. At the same time colder currents descend from greater heights to fill the space left by the ascending currents.

Quite different, however, is the influence of the sun's rays on water. In this case the solar rays are very far from being altogether arrested at the surface, but penetrate to a very considerable depth. The heating effect of the sun has been shown by the observations of the Challenger to be distinctly appreciable to a depth of 500 feet below the surface of the sea.

The rate at which, in clear water, the heating effect takes place at different depths is a problem not yet worked out, being very difficult of even an approximate solution owing to the presence of the relatively large numbers of dust particles which even the clearest water contains. Since water is a bad conductor, the heat thus distributed

cannot be considered, as holds good in the case of land, to penetrate by conduction to greater depths, only doing so when increased densities, due to evaporation or other causes, carry the higher temperature to greater depths. The rate of diffusion downwards may be regarded as proportional to the vertical density gradient from the surface layers downward.

Hence the vital distinction between land and water surfaces in their bearings on climate lies in this, that nearly all the sun's heat falling on land is arrested on the surface, but as regards water it is at once transmitted downwards to great depths. In shallow water, the sun's heat raises the temperature much higher than in deep water, for the obvious reason that nearly all solar radiation falling on the surface raises the temperature of the shallow layer of water; in other words, the influence of the heat rays of the sun is concentrated on a small depth of water, instead of being diffused through a great depth. On the other hand, water more or less turbid by the presence of organic or inorganic matter, is more highly heated near the surface.

Surface Temperature of the Sea.—When it is considered that three-fourths of the earth's surface is water, that the temperature of the air resting on its surface is in closest relation to the temperature of the surface, and that the latter has, through the winds, direct and all-important bearings on the temperature of the land surfaces of the globe, it is at once seen to be impossible to overstate the importance of this datum of meteorology. It will also appear further on to have bearings equally important in the elucidation of the fundamental principles of the science.

Among the first, if not the first, contributions for determining the diurnal march of the temperature of the surface of the sea were those made by Captain Thomas, R.N., during the years 1859–63, while engaged on the survey of the islands on the north-west of Scotland. During this survey, observations of the temperature of the sea were made every hour of the day at all seasons, and with a frequency sufficient for the determination of the diurnal range of the temperature of the surface. From these observations it has been shown[1] that the daily minimum, 0°·17 below the mean,[2] occurred about 6 A.M.; the mean about 11 A.M.; the maximum, 0°·13 above the mean, between 3 and 4 P.M.; and the mean again shortly before 2 A.M. Hence the daily oscillation of the temperature of the open sea off the north-west of Great Britain is only 0°·3.

During the cruise, the temperature of the surface of the sea was observed every two hours as part of the scientific work of the Expedition. From these observations the deviations each two hours of the day from the mean daily temperature of the surface of the sea have been calculated, and the results are given in Table I., App. pp. 1–3. The periods for which the averages have been calculated are about five days, more or less, and in those cases in which the temperature at the beginning of the

[1] *Journal of the Scottish Meteorological Society*, vol. i. pp. 265–270.

[2] The temperatures in this Report are Fahrenheit.

period differed considerably from that at the close, a correction has been applied so as to give the true deviations from the daily means for the observed hours. It will be seen, from an examination of the Table, that in nearly all cases the short periods adopted give results closely approximate to the mean diurnal variations. In a very few cases, such as the period of six days from October 3 to 8, 1875, when the Challenger was in the South Pacific, mean position lat. 21° 20′ S., long. 149° 40′ W., the usual distribution of the daily temperature was reversed, the maximum occurring early in the morning, and the minimum early in the afternoon. All such anomalous results were due to the track of the Challenger at the time being across a succession of warm and cold currents, the differences of whose temperatures, combined with the hours of the day at which the observations were made, gave the curve of the diurnal variation for the period its anomalous character.

The diurnal variation of the temperature of the surface of the North Atlantic has been calculated from the observations made on the one hundred and twenty-six days from March to August 1873, and in April and May 1876, the mean latitude of all the points of observation being nearly 30° N. and the longitude 42°. The following are the two-hourly deviations from the mean (Plate I. fig. 1):—

2 A.M.	−0°·2	10 A.M.	0°·1	6 P.M.	0°·3
4 ,,	−0°·3	Noon	0°·2	8 ,,	0°·0
6 ,,	−0°·3	2 P.M.	0°·5	10 ,,	−0°·2
8 ,,	−0°·1	4 ,,	0°·5	Midt.	−0°·3

Thus in Mid Atlantic, about lat. 30° N., where the sun's heat is strong, and at the time of the year when the sun is north of the equator, the diurnal fluctuation of the temperature of the surface is only 0°·8. Similarly in the South Atlantic, lat. 33° S. and long. 20° W., the mean diurnal fluctuation is 0°·8, or the same as in the North Atlantic. In the North Pacific, near lat. 37° N. and long. 170° W., it is 1°·0; and in the South Pacific, near lat. 36° S. and long. 87° W., it is 0°·9. Hence the general diurnal range of temperature near the centres of these four great oceans, and near the summer solstice, is a little less than a degree. On the other hand, near the equator both in the Atlantic and Pacific the diurnal range is only 0°·7, being thus 0°·2 less than about lat. 36°, a difference probably due to the more clouded skies and less sunshine of equatorial regions. In February 1874, when the mean position of the Challenger was nearly lat. 61° S., the difference between the mean coldest and warmest hour was only 0°·2. The mean daily range deduced from the whole of the observations made during the three years and a half is 0°·8.

The small daily variation of the temperature of the surface of the sea shown by the Challenger observations is unquestionably a most important contribution to physical science, forming in truth one of the prime factors in meteorology, particularly, as will appear further on, in the discussions relating to atmospheric pressure and winds.

Temperature of the Air over the Open Sea.—Table II., App. pp. 4–6, which has been constructed similarly to Table I., shows the deviations each two hours from the mean daily temperature of the air as observed on board the Challenger. The following figures show the daily march of the temperature of the air over the North Atlantic on a mean of the same one hundred and twenty-six days for which the temperature of the sea has been given (Plate I. fig. 2):—

2 A.M.	−1°·1	10 A.M.	0°·8	6 P.M.	0°·7
4 ,,	−1°·4	Noon	1°·4	8 ,,	−0°·3
6 ,,	−1°·4	2 P.M.	1°·8	10 ,,	−0°·8
8 ,,	−0°·2	4 ,,	1°·6	Midt.	−1°·0

The amplitude of the daily fluctuation is thus 3°·2. In the South Atlantic, about lat. 36° S. and long. 36° W., the diurnal range of temperature is 2°·5; in the North Pacific, about lat. 37° N. and long. 168° W., 3°·1; and in the South Pacific, about lat. 36° S. and long. 100° W., 4°·0. In the neighbourhood of the equator in the Atlantic, about long. 18° W., the daily range is 2°·6, and in the Pacific, about long. 145 E., 2°·1. Hence while the mean daily range of temperature of the air in the anti-cyclonic regions of the four great oceans is 3°·2, in the neighbourhood of the equator, where the sky is more clouded, it is about a degree less. In high latitudes the daily range is much less, as will appear from the following table:—

Number of Days' Obs.	Lat. S.	Long. E.	Daily Range of Temp. of Air.
18	62° 40′	85° 26′	0°·8
10	54° 5′	73° 14′	1°·8
10	51° 54′	117° 47′	1°·5
6	47° 16′	56° 23′	1°·9

The general result is that the daily range of the temperature of the air on the open sea is from three to four times greater than that of the surface temperature of the sea over which it lies.

Part of this increased daily range of the temperature of the air as compared with that of the sea was no doubt occasioned by a higher temperature during the day and a lower during the night on the deck of the Challenger as compared with that of the free atmosphere over the sea all round. But, after making allowance for this disturbing influence, it may be assumed that the temperature of the air has a considerably larger daily range than that of the sea on which it rests. The point is one of no little interest in atmospheric physics from its important bearings on the relations of the air and its watery vapour, in its gaseous, liquid, and solid states, and of the particles of dust everywhere present, to solar and terrestrial radiation.

During the same months, which gave on the mean of one hundred and twenty-six days a daily range of temperature of 3°·2 over the open sea, the Challenger was lying near land on seventy-six days. The observations made on these days showed a greater daily range than out on the open sea. The minimum, −2°·1, occurred at 4 A.M., and the maximum, 2°·3, at noon, thus giving a daily range of 4°·4. It is interesting to note the frequency with which the mean daily maximum occurred as early as noon when the Challenger was in harbour, a result probably due to the diurnal period of the sea breezes in such situations in tropical and subtropical regions. Generally speaking, at High Level Stations and in situations within the influence of well-marked sea breezes, the time of occurrence of the daily maximum temperature is about two hours earlier than in inland open situations.

Brewster made the remark many years ago, that, as regards land observations, the mean of any pair of hours of the same name, such as 2 A.M. and 2 P.M., 4 A.M. and 4 P.M., etc., does not differ very materially from the mean temperature of the day.

The following are the deviations from the mean temperature of the air of the separate pairs of hours for the one hundred and twenty-six days of the North Atlantic given above:—

	Deviation from the Mean.
2 A.M. and 2 P.M.,	+0°·3
4 " " 4 "	+0°·1
6 " " 6 "	−0°·3
8 " " 8 "	0°·0
10 " " 10 "	0°·0
Noon and midnight,	+0°·2

The result for the six hours, 4, 8 A.M. and P.M., noon and midnight, is +0°·1, and for the six hours 2, 6, and 10 A.M. and P.M., 0°·0.

In the Isothermal Maps for the globe given in this work, the isothermals for the North Atlantic have been drawn from the data published in the "International Meteorological Observations" of the United States. But as the observations are made as near as possible at the same physical instant, they were first corrected for Diurnal Range from the results given in this table.

Variation of the Humidity of the Air.—The observations on the humidity of the atmosphere were made with the ordinary dry and wet bulb thermometers, from which the absolute and relative humidities have been calculated by Glaisher Tables.

If the aqueous vapour remained permanently and unchanged in the atmosphere, that is, if it were not liable to be condensed into cloud or rain, the mixture would become as complete as that of the oxygen and nitrogen of the air. The equilibrium of the vapour atmosphere, however, is being constantly disturbed by changes of temperature, by every instance of condensation, and by the unceasing process of evaporation. Since

dry air materially obstructs the free diffusion of the aqueous vapour, the law of the independent pressure of the vapour and the dry air of the atmosphere holds good only approximately. The aqueous vapour, however, constantly tends to approach this state. The important conclusion follows, that the hygrometer can never indicate more than the local humidity of the place where it is observed. While then in certain cases the amount of vapour indicated by the dry and wet bulb readings is far from the truth, yet in averages, particularly long averages, a close approximation to the real humidity of the locality is attained if the hygrometer be at all tolerably well exposed and carefully manipulated and observed.

Aqueous vapour is being constantly added to the air from water, snow, and other moist and frozen surfaces. The rate of evaporation is greatest when the air is driest or freest from vapour, and least when it is nearest the point of saturation. As air expands under a diminished pressure, its temperature consequently falls, and it continues to approach nearer the point of saturation, or to become moister; and as it contracts under an increased pressure, its temperature rises, and it recedes from the point of saturation, or becomes drier. Hence ascending currents of air become moister with every addition to the ascent, and descending currents drier as they continue to descend.

The pressure exerted by the aqueous vapour in the atmosphere, or, as it is usually called, the elastic force of vapour, is expressed in decimals of an inch of the mercurial barometer. It indicates the quantity of aqueous vapour in the air at the place of observation, and in this light may be viewed as the absolute humidity of the air as there observed. It cannot, however, be regarded as indicating the pressure due to the aqueous vapour of the whole atmosphere over the place of observation, since we are still very ignorant of the distribution of the aqueous vapour with height. Now the diurnal variation in the elastic force of vapour in the air is seen in its simplest form over the open sea. Grouping together all the hygrometric observations made on board the Challenger in the North Atlantic, at a distance from land, from March to July 1873, eighty-four days in all, there being for that time a mean elastic force of 0·659 inch, the following is the diurnal variation (Plate I. fig. 3) :—

	Inch.		Inch.		Inch.
2 A.M.	−0·015	10 A.M.	+0·004	6 P.M.	+0·007
4 ,,	−0·020	Noon	+0·017	8 ,,	+0·002
6 ,,	−0·016	2 P.M.	+0·020	10 ,,	−0·005
8 ,,	−0·007	4 ,,	+0·017	Midt.	−0·010

Thus the minimum, −0·020 inch, occurs at the hour when the temperature of the surface of the sea and air resting over it falls to the daily minimum; it then rises to the mean a little after 9 A.M.; to the daily maximum, +0·020 inch, at 2 P.M., when the temperature of the sea and air are also near the daily maximum; and falls to the mean

shortly before 9 P.M. But it is only on the open sea, at a distance from land, where this typical curve of the diurnal humidity occurs with its single minimum and maximum. Over land the humidity daily curve shows two well-marked minima and maxima—the two minima occurring in the early morning and in the afternoon; and the more inland the situation and stronger the sun, the more strongly marked is the afternoon minimum. Now the hygrometric observations made near land show a daily humidity curve intermediate between these two. The observations made near land in the North Atlantic, during the same months, disclose the following diurnal variations (Plate I. fig. 4):—

	Inch.		Inch.		Inch.
2 A.M.	−0·003	10 A.M.	+0·014	6 P.M.	0·000
4 ,,	−0·009	Noon	+0·010	8 ,,	−0·004
6 ,,	−0·010	2 P.M.	+0·007	10 ,,	−0·005
8 ,,	−0·003	4 ,,	+0·015	Midt.	−0·007

The disturbance due to proximity to land in the diurnal distribution of the aqueous vapour in the lower stratum of the atmosphere is remarkable. The maximum and minimum no longer follow the corresponding phases of the temperature of the surface of the sea and the air. The disturbing agents are the land and sea breezes, with the other atmospheric movements resulting from the unequal heating of land and water. Under the influence of the land breeze, the time of minimum humidity is delayed till about 6 A.M. The most remarkable feature of the curve, however, is the occurrence of a secondary minimum of humidity, for some hours between 10 A.M. and 4 P.M., a feature altogether absent in the atmosphere over the open sea. It is to be noted that this mid-day minimum occurs at the hours of the day when, the surface of the land being most highly heated, the ascending current of heated air rising from it is strongest, and the resulting breeze from the sea towards the land therefore also strongest. This diminution in the amount of aqueous vapour, recorded on board the Challenger when near land, points unmistakably to an intermixture, with the air forming the sea breeze, of descending thin air filaments or currents to take the place of the masses of air removed by the currents which ascend from the heated surface of the land; and this increased dryness occurs also in the air of the sea breezes as they near the land.

The relative humidity of the air, or, as it is more frequently called, its humidity, is the degree of its approach to complete saturation. Complete saturation is represented by 100, and air absolutely free of vapour by 0. The latter, however, never occurs in the free atmosphere. About the lowest relative humidity, or driest state of the atmosphere hitherto recorded with the requisite care and accuracy, was 6 per cent. at the Ben Nevis Observatory at 8 P.M. of March 12, 1886, on which day the mean of the twenty-four hourly observations was only 15 per cent.

The diurnal variation of the relative humidity, which is quite different from that

of the vapour pressure, is of the simplest description. The following are the deviations from the mean daily humidity, 80 per cent., over the North Atlantic, from the observations made on that ocean in 1873 (Plate I. fig. 5):—

	Per cent.		Per cent.
2 A.M.	+2	2 P.M.	−3
4 ,,	+2	4 ,,	−2
6 ,,	+1	6 ,,	−1
8 ,,	0	8 ,,	0
10 ,,	−1	10 ,,	+1
Noon	−2	Midt.	+2

Hence the maximum humidity takes place from midnight to 4 A.M., and the minimum from noon to 4 P.M., in other words, when the temperature of the air is at the daily minimum and maximum respectively, the curve of humidity being thus simply inverse to that of the temperature. These are, substantially, the prominent phases of the curve of humidity for all climates and seasons, subject, however, to a slight increase in sea-side climates during the hours of the day of the prevalence of the sea breeze.

The significance of this constituent of climate lies in its relations to the diathermancy of the air, and to the dust particles everywhere present in it, and consequently to the all-important questions of solar and terrestrial radiation. It is assumed, with high probability, that perfectly pure and dry air, or air quite free from aqueous vapour and dust particles, permits rays of heat to pass through it with at most no more than a very slight increase to its temperature. We are yet without exact information as to whether a mixture of the air with aqueous vapour as a pure gas only, is equally diathermanous with dry air. Whether this be so or not, it may be regarded as certain that the atmosphere never interposes between the earth and the sun a purely gaseous aerial screen, but that it everywhere, even when apparently quite clear, contains minute particles of dust, and water either in the fluid state, or in the solid state as small spicules of ice.

Next to the winds, the aqueous vapour of the air, in its amount and relation to solar and terrestrial radiation, and in the different ways in which in different localities it is partitioned through the hours of the day and months of the year, plays the most important part in giving to the various regions of the globe their infinitely diversified climates.

Oscillations of the Barometer. Tables III. and IV., App. pp. 7–48.—The general character of the diurnal oscillations of atmospheric pressure is shown by figs. 6 and 7 of Plate I. Fig. 6 represents the mean oscillation for Batavia, lat. 6° 11′ S., long. 106° 50′ E., and fig. 7 a strictly ocean oscillation in the Pacific in lat. 1° 10′ S. and long. 150° 46′ W. Both figs. show two maxima about 10 A.M. and 10 P.M., and two minima about 4 A.M. and 4 P.M. respectively. The two situations are near the equator, the one on the coast of Java and the other in mid ocean. In the latter the

phenomena are shown in their simplest form, whilst at Batavia the more striking effects of the influence of land are apparent.

In order to show the constancy, or otherwise, of the times of occurrence of the maxima and minima, a series of twelve maps of the globe were prepared for the month of June, showing at all stations from which the required data have been obtained, the deviations at noon, 2 P.M., 4 P.M., etc., G.M.T., from the daily mean pressure; and thence four lines were drawn showing the places where, at that hour, the maxima and minima occurred. For fully 30° north and south of the equator the lines of maxima and minima ran north and south, but in higher latitudes these lines are changed, particularly as regards the forenoon maximum and the afternoon minimum. For example, at 6 P.M. the line indicating the afternoon minimum is for the latitude of London in long. 16° W.; in lat. 30° N., it is in long. 35° W., in which meridian it holds its course southwards as far as lat. 30° S.; its course thence turns south-westwards to near the Falkland Islands, long. 60° W. It follows that in June the afternoon minimum occurs about three hours earlier in the Falkland Islands than in the south-west of Ireland, thus showing in a striking manner the influence of season on the diurnal phenomena of pressure. In cases where the lines of maxima and minima cross such regions as southern and western Europe, whose surface is diversified by large tracts of land and sheets of water, the deflexions are peculiarly striking and instructive.

In middle and higher latitudes in summer, proximity to the sea, conspicuously so when the station is situated on the west coasts of continents and islands, delays the time of occurrence of the morning maximum and the afternoon minimum; whilst in continental situations the morning maximum occurs much earlier than in lower latitudes, and the evening minimum nearly as late as at places near the sea. It appears from the Challenger observations that these peculiarities of the curves do not occur over the open sea in the higher latitudes.

The retardation of the time of occurrence of the morning maximum is greatest in situations which, while strongly insular in character, are at the same time on, or not far from, an extensive tract of land to eastward or south-eastward. This is well illustrated by the hourly oscillations of the barometer for the year at Helder, in the north-west of Holland, and Sitka, in the south-east of Alaska (Table IV., App. pp. 28 and 36). The deviations from the means are given in thousandths of an inch.

It is seen that at Helder, the morning maximum occurs at times varying from nine to ten o'clock in the beginning of the year, and successively later as the year advances, till in June it is delayed to 2 P.M., and thereafter it occurs earlier and earlier month by month till January, when it is at the earliest. The following selected cases of the hourly deviations of pressure in June illustrate the gradual occurrence earlier of this phase according as the place becomes less insular as described above, the series closing with Kew and Culloden, to which are added Katherinenburg and Fort Rae. A selection of these is plotted on Plate I., figs. 8–15.

TABLE showing the Diurnal Oscillation of the Barometer in June, in Thousandths of an Inch.

The Heavy Figures show a pressure above, the Italic Figures below, the Means.

	Sitka.	Helder.	Keitum.	Valentia.	Falmouth.	Amsterdam.	Wustrow.	Neufahrwasser.	Pola.	Helsinfors.	St. Petersburg.	Hamburg.	Kew.	Culloden.	Katherinenburg.	Fort Rae.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Lat. N.	57 3	52 57	54 54	51 55	50 9	52 22	54 21	54 24	44 52	60 14	59 56	53 33	51 28	57 29	56 49	62 39
Long.	−135 18	4 40	8 22	−10 18	−5 4	4 53	12 24	18 40	13 50	24 57	30 16	9 58	−0 19	−4 8	60 38	−115 44
1 A.M.	**1**	*4*	*0*	**1**	*2*	**5**	*2*	**3**	*2*	**5**	*0*	**1**	**5**	**8**	**5**	**1**
2 ,,	*1*	*11*	*5*	*7*	*10*	*3*	*7*	*3*	*5*	*2*	*0*	*5*	**2**	**3**	**5**	**2**
3 ,,	*2*	*17*	*9*	*14*	*17*	*10*	*11*	*8*	*10*	*6*	*0*	*6*	*2*	**3**	**4**	**2**
4 ,,	*5*	*18*	*12*	*20*	*20*	*12*	*11*	*10*	*11*	*6*	*1*	*5*	*1*	**4**	**4**	**4**
5 ,,	*6*	*17*	*13*	*19*	*19*	*12*	*10*	*10*	*7*	*4*	*0*	*2*	**2**	**4**	**5**	**6**
6 ,,	*6*	*13*	*12*	*16*	*14*	*10*	*6*	*6*	*3*	*1*	*0*	**2**	**6**	**5**	**6**	**9**
7 ,,	*7*	*7*	*9*	*12*	*8*	*7*	*1*	*2*	**2**	**1**	**2**	**6**	**10**	**5**	**8**	**10**
8 ,,	*6*	*4*	*7*	*7*	*3*	*3*	**4**	**0**	**9**	**5**	**3**	**11**	**12**	**5**	**8**	**11**
9 ,,	*6*	*0*	*4*	*3*	*0*	**0**	**7**	**3**	**12**	**8**	**5**	**12**	**11**	**4**	**8**	**11**
10 ,,	*4*	**3**	**1**	**1**	**2**	**3**	**10**	**5**	**16**	**9**	**7**	**11**	**9**	**0**	**5**	**9**
11 ,,	*1*	**4**	**4**	**5**	**6**	**4**	**11**	**5**	**17**	**11**	**7**	**9**	**6**	*1*	**2**	**8**
Noon	**3**	**4**	**5**	**7**	**7**	**9**	**10**	**6**	**18**	**11**	**7**	**5**	**2**	*4*	*1*	**6**
1 P.M.	**4**	**9**	**7**	**7**	**7**	**8**	**7**	**4**	**11**	**9**	**5**	**2**	*5*	*7*	*5*	**3**
2 ,,	**6**	**11**	**7**	**6**	**6**	**6**	**5**	**2**	**5**	**5**	**2**	*2*	*10*	*7*	*7*	**1**
3 ,,	**6**	**7**	**7**	**6**	**5**	**4**	**4**	**0**	*1*	**1**	**0**	*5*	*13*	*8*	*9*	*3*
4 ,,	**6**	**5**	**5**	**4**	**3**	**2**	**1**	*1*	*7*	*2*	*2*	*10*	*17*	*11*	*13*	*8*
5 ,,	**4**	**3**	**2**	**3**	**1**	*1*	*1*	*3*	*13*	*5*	*5*	*13*	*20*	*11*	*15*	*10*
6 ,,	**3**	**2**	**2**	**4**	**2**	*2*	*3*	*3*	*15*	*6*	*7*	*13*	*18*	*6*	*13*	*12*
7 ,,	**1**	**4**	**2**	**5**	**3**	*2*	*4*	*4*	*13*	*6*	*7*	*10*	*12*	*3*	*11*	*13*
8 ,,	**1**	**5**	**3**	**7**	**5**	**3**	*4*	*1*	*9*	*6*	*7*	*6*	*4*	**3**	*5*	*13*
9 ,,	**3**	**11**	**7**	**9**	**13**	**9**	*1*	**5**	*1*	*5*	*4*	**1**	**6**	**6**	**1**	*10*
10 ,,	**3**	**10**	**8**	**14**	**14**	**11**	**2**	**5**	**2**	**2**	*3*	**3**	**11**	**6**	**5**	*7*
11 ,,	**4**	**7**	**7**	**11**	**11**	**12**	**1**	**6**	**3**	**4**	*1*	**4**	**12**	**7**	**6**	*5*
Midt.	**2**	**7**	**4**	**6**	**9**	**8**	*2*	**3**	**1**	**5**	*0*	**3**	**10**	**6**	**6**	*2*

In the British islands, the curve most characteristic of insular climates is that of Valentia, and that most characteristic of continental climates is the curve for Culloden, these two curves being nearly throughout the reverse of each other. The times of occurrence of the morning maximum are respectively 1 P.M. and 7 A.M., or six hours apart. A comparison of the curves for Kew and Culloden, and of these with the curves for Katherinenburg and Fort Rae, in the interior of the continents of Asia and North America respectively, is very interesting. In insular situations, the morning minimum is unusually large, whilst the afternoon minimum becomes, in the more strictly insular situations, so small as almost to disappear; but, on the other hand, in continental situations, the afternoon minimum is strongly pronounced, whilst the morning minimum tends to vanish, and in many cases disappears altogether,—of which Fort Rae is an example (fig. 15),—thus reducing the phenomena to one daily tide.

It is to be specially noted that the morning maximum attains the time of greatest retardation in June, when the sun is highest in the heavens, and not in July, when nearly all meteorological conditions show one of their two most prominent annual phases. From this result, the important conclusion follows that the phenomena of the diurnal barometric range are not cumulative, but that in their relation to the sun they

are direct. The movement from east to west is only quasi-tidal, being quite different from the manner in which the tides of the ocean are propagated from place to place over the earth's surface. The barometric tides are in truth directly generated by solar and terrestrial radiation in the regions where they occur, and it is in this way that the great variation revealed by observation in the curves of restricted districts comparatively near each other are to be explained.

From hourly observations made in June at the base, the top, and two intermediate points on Mount Washington, N.H. (Table IV. p. 48, and Plate I. figs. 16–19), it is seen that the time of occurrence of the morning maximum at the base of the mountain, 2898 feet above the sea, was 8 A.M.; at 4059 feet, 10 A.M.; at 5533 feet, 11 A.M.; and at the top, 6285 feet, noon. Hence, as regards this phase of the oscillation, and the steady diminution with height of the afternoon minimum, the influence of an isolated mountain like Mount Washington brings about a result quite similar to what is observed in insular situations. But the analogy of the curves of the two situations is closer still, the morning minimum in both being very strongly pronounced. Similarly in summer on the top of Ben Nevis, the morning maximum is retarded to 3 P.M., being seven hours later than the time of occurrence of the same phase at the base of the mountain; and the morning minimum is very large, whilst the afternoon minimum all but vanishes (Table IV. p. 27).

The differences offered by the daily curve of pressure at the top as compared with that at the base of a mountain are the simple results of the diurnal march of temperature. As the temperature of the air is lowest in the early morning, and the atmosphere therefore more condensed in the stratum between the top and base of the mountain, a portion of the atmosphere necessarily sinks bodily below the level of the top, thus lessening the whole pressure there. On the other hand, as temperature rises during the day with the returning sun, the stratum of air above the base of the mountain expands, thus raising more of the atmosphere above the barometer at the top, so that while at the base of the mountain pressure begins to fall about 9 A.M., on the top it continues to rise at the Ben Nevis Observatory till about 3 P.M., simply from the mechanical upheaval of the air owing to its higher temperature. This feature of the curve of pressure at the top of a mountain is thus essentially and immediately a temperature effect, resulting from the diurnal contraction and expansion with the changes of temperature of the aerial stratum between the top and bottom of the mountain.

The above curves of diurnal pressure have all been selected, it will be observed, from places situated in comparatively high latitudes, where the departures of the maxima and minima from the mean pressure are small; the object in selecting curves of small daily range being to present in as striking prominence as may be done the modifications impressed on the diurnal barometric fluctuations by mere height and by large tracts of land and sheets of water in respect of the extremely different conditions of surface temperature they offer at different hours of the day.

The following selection from places in comparatively low latitudes are intended to represent the effect of land and sea, and of dry and moist climates respectively, on the phenomena of the diurnal range of pressure. The differences from the means are given in thousandths of an inch.

	Jacob-abad.	Ahmed-nugger.	Aden.		Bombay.		Dodabetta.	Havana.		Hong Kong.		Zi-ki-wei.		Ascen-sion.	St. Helena.	CHALLENGER OBSERVATIONS.				
Lat.	° ′ 28 19	° ′ 19 6	° ′ 12 46		° ′ 18 54		° ′ 11 32	° ′ 23 8		° ′ 22 18		° ′ 31 12		° ′ −7 55	° ′ −15 55	° ′ 2 50	° ′ 4 8	° ′ −1 10	° ′ −30 59	° ′ 28 8
Long.	68 24	74 16	45 5		72 49		76 50	−82 23		114 10		121 20		−14 25	−5 43	−21 9	124 46	−150 46	−25 40	138 25
Month.	Feb.	April.	Jan.	Aug.	Jan.	July.	May–July.	Jan.	June.	Jan.	June.	Jan.	June.	Year.	Year.	Aug. 16–31	Oct. 11–31	Sept. 1–12	Oct. 1–14	April.
1 A.M.	—	—	*17*	*25*	*7*	*10*	*12*	7	5	8	3	*1*	*2*	1	*4*	—	—	—	—	—
2 ,,	—	—	*39*	*25*	*18*	*23*	*24*	*0*	*6*	*1*	*7*	*6*	*10*	*11*	*16*	*8*	*10*	*9*	*14*	*12*
3 ,,	—	—	*45*	*23*	*28*	*30*	*41*	*7*	*12*	*10*	*13*	*13*	*14*	*17*	*26*	—	—	—	—	—
4 ,,	—	—	*36*	*7*	*28*	*30*	*35*	*8*	*19*	*15*	*14*	*18*	*13*	*16*	*26*	*24*	*22*	*21*	*26*	*23*
5 ,,	—	—	*21*	9	*19*	*23*	*25*	*7*	*15*	*14*	*11*	*17*	*6*	*9*	*21*	—	—	—	—	—
6 ,,	—	40	*7*	31	*3*	*7*	*18*	4	*7*	*3*	2	*6*	5	2	*7*	*7*	*2*	4	*8*	8
7 ,,	70	50	18	50	21	9	*1*	14	4	13	13	8	15	13	8	—	—	—	—	—
8 ,,	87	77	34	67	48	23	19	29	9	34	23	27	21	25	23	22	32	29	13	17
9 ,,	97	74	44	90	68	33	31	37	14	51	30	37	22	32	34	—	—	—	—	—
10 ,,	85	57	42	90	68	37	44	39	21	55	32	43	22	30	36	32	45	33	29	30
11 ,,	50	44	18	67	50	32	36	26	14	42	27	29	19	22	29	—	—	—	—	—
Noon.	8	25	*12*	14	19	21	30	3	8	16	18	4	12	8	15	17	12	7	9	12
1 P.M.	*32*	*4*	*14*	*6*	*13*	7	15	*20*	2	*19*	2	*20*	*0*	*10*	*1*	—	—	—	—	—
2 ,,	*64*	*43*	*26*	*31*	*38*	*6*	4	*33*	*7*	*39*	*13*	*30*	*9*	*26*	*15*	*10*	*33*	*44*	*6*	*9*
3 ,,	*86*	*60*	*41*	*57*	*50*	*20*	*8*	*43*	*15*	*51*	*26*	*34*	*17*	*36*	*27*	—	—	—	—	—
4 ,,	*90*	*79*	*38*	*63*	*51*	*30*	*29*	*41*	*25*	*50*	*37*	*23*	*25*	*38*	*30*	*33*	*48*	*56*	*16*	*23*
5 ,,	*76*	*80*	*20*	*73*	*45*	*30*	*32*	*36*	*27*	*41*	*39*	*19*	*29*	*32*	*27*	—	—	—	—	—
6 ,,	*61*	*61*	2	*60*	*31*	*20*	*24*	*26*	*17*	*29*	*32*	*8*	*25*	*27*	*18*	*18*	*28*	*29*	*10*	*11*
7 ,,	*24*	*45*	14	*39*	*11*	6	6	*13*	*7*	*15*	*21*	4	*12*	*6*	*7*	—	—	—	—	—
8 ,,	2	*14*	25	*14*	6	7	4	3	3	4	*4*	11	1	9	7	1	4	3	8	*4*
9 ,,	29	0	24	15	20	18	26	14	15	13	8	14	12	20	18	—	—	—	—	—
10 ,,	—	—	22	11	22	24	31	19	22	18	22	14	19	27	24	20	30	18	12	9
11 ,,	—	—	10	*5*	14	19	25	23	27	20	22	8	12	25	20	—	—	—	—	—
Midt.	—	—	*3*	*11*	4	6	4	16	15	17	12	2	8	15	10	13	19	11	9	8

A selection from the hourly barometric oscillations of the Challenger is included in the table, from which it is seen that on small islands, such as Ascension and St. Helena, and, during the rainy season, of such localities as Havana, Bombay, Hong Kong, and Zi-ki-wei, the amounts and times of occurrence of the maxima and minima closely agree with what were observed on board the Challenger over the open sea in like latitudes.

The influence of the land, in dry climates, in increasing the amount of the oscillation is most strikingly shown at Jacobabad, where pressure rises at 9 A.M. to 0·097 inch above the mean, and at 4 P.M. falls to 0·090 inch below it, thus showing the large range of nearly two-tenths of an inch. At Aden, where the climate is dry at all seasons, the fall from the morning maximum to the afternoon minimum is 0·084 inch in January, whereas in August it amounts to 0·163 inch, or nearly double that of January, when the sun occupies a lower place in the sky. On the other hand, at Bombay, during the dry season in January, the range is 0·119 inch, but during the wet season in July, though the sun's position is then nearly vertical, the range is only 0·067 inch. The same peculiarity is seen in the corresponding seasons of Havana, Hong Kong, and Zi-ki-wei. At Dodabetta, 8640 feet high, the relatively lower morning minimum and retardation of the morning maximum, which characterise the curves of High Level Stations in the higher latitudes, are well illustrated.

Among the most valuable of the physical results arrived at from the observations made on board the Challenger—valuable from the important conclusions to which it leads—is the fact that the diurnal range of the mean surface temperature of the sea does not anywhere exceed a degree Fahrenheit, whilst the diurnal oscillations of the barometer occur over the open sea as well as over the land surfaces of the globe. It follows, therefore, that the atmosphere over the open sea rests on a floor or surface, subject to a diurnal range of temperature so small as to render the temperature practically constant both day and night.

This consideration leads at once to the all-important conclusion that the diurnal oscillations of the barometer are not caused by the heating and cooling of the earth's surface by solar and terrestrial radiation, and by the effects which follow these diurnal changes in the temperature of the surface, but that they are primarily caused by the direct heating by solar radiation and cooling by nocturnal radiation to the cold regions of space, of the molecules of the air and of its aqueous vapour, these changes of temperature being instantaneously communicated through the whole mass of the atmosphere from its lowermost stratum resting on the surface to the extreme limit of the atmosphere. There are, as has been shown, important modifications, affecting the amplitude and times of occurrence of the four principal phases of the phenomena, observed over land surfaces, the temperature of which is superheated during the day and cooled during the night, as observed in climates widely different as regards the

amount of aqueous vapour present in the atmosphere; but it is here particularly insisted on that the barometric oscillations themselves are independent of any changes of temperature of the floor on which the atmosphere rests. We shall, then, consider the phenomena chiefly, as the results of observation present them to us, as existing over the free ocean, and therefore cleared of all complications arising from the diurnal heating of the surface.

Physicists are divided in opinion as to whether the aqueous vapour of the air, while in the purely gaseous state, is or is not as diathermanous as is the dry air of the atmosphere, no decisive experiment having yet been made to prove the relation of purely gaseous vapour to radiant heat. But it is quite different as regards the water suspended in the atmosphere in the liquid, and in the solid form in minutely divided states, and as regards the particles of dust which recent research has shown to be everywhere present in the atmosphere. It is from Mr. John Aitken's ingenious experiments and researches that an insight may be obtained as to the relations of the dust particles to the aqueous vapour of the atmosphere.

Mr. Aitken showed, in his paper on Dust, Fogs, and Clouds,[1] that a solid nucleus is necessary for the condensation of water-vapour in the formation of fogs and clouds, and in subsequent communications to the Royal Society of Edinburgh he has shown that even the purest air that can be obtained contains an enormous number of fine dust particles. The purest air examined, which was obtained at Ben Nevis Observatory, contained 2100 dust particles per cubic inch; in Edinburgh, on a fine clear day, the number was 738,000; whilst in air taken from near the ceiling of a hall about the close of a meeting, the dust particles to the cubic inch were 57,400,000.

Let us now look at the phenomena of the diurnal oscillation as found in the Pacific near the equator, and in the midst of the largest water surface of the globe. Plate I. fig. 7 shows the hourly variations of pressure from observations by the Challenger, September 1 to 12, 1875, in mean lat. 1° 10′ S. and long. 150° 4′ W., the mean pressure for these days having been 29·928 inches. The most remarkable feature of the curve is the amplitude of the range from the morning maximum to the afternoon minimum, and the rapidity of the fall in the four hours from 10 A.M. to 2 P.M., amounting to 0·087 inch. This and the other features of the curve are substantially the same for all positions on the open sea for at least 12° on each side of the equator. In higher latitudes, over land, in anticyclonic regions, and in particular geographical situations, the curves become more or less modified. They all agree in showing the double maxima and minima, except in a few restricted regions of high latitudes already referred to.

If the temperature of the whole of the earth's atmosphere were raised, atmospheric pressure would be diminished, inasmuch as the mass of the earth's atmosphere would thereby be removed to a greater distance from the earth's centre of gravity. But quite

[1] *Trans. Roy. Soc. Edin.*, vol. xxx. pp. 337–368.

different results would follow if the temperature of only a section of the atmosphere were suddenly raised, such as the section, resembling the "lith" or division of an orange, comprised between 150° and 180° west longitude. The immediate effect would be an increase of barometric pressure from the expansion due to the higher temperature, and a subsequent effect would be the setting in of an ascending current, more or less powerful in proportion to the differences between the temperature of the heated section and that of the air on each side. These are essentially the conditions under which the morning maximum and the afternoon minimum take place.

The earth makes a complete revolution round its axis in twenty-four hours, and in the same brief interval the double-crested and double-troughed atmospheric diurnal tide makes a complete circuit of the globe. The whole of the diurnal phenomenon of the atmospheric tides is therefore rapidly propagated over the surface of the earth from east to west, and, as the movement of the surface is necessarily most rapid in equatorial regions, the amplitude of the oscillations there is greater than in higher latitudes under similar astronomical, geographical, and atmospherical conditions.

The Morning Minimum.—This depression of the barometric curve occurs from a little before midnight to near sunrise, or during the time when the effects of nocturnal radiation in lowering the temperature are the greatest. Pressure falls to the minimum about four in the morning.

Assuming that aqueous vapour in its purely gaseous state is as diathermanous as the dry air of the atmosphere, let us consider the part played by the dust particles suspended in the air. As nocturnal radiation proceeds, the temperature of each dust particle continues to fall below that of the air immediately surrounding it. From this state of things two important consequences follow—1st, the temperature of the whole atmosphere falls, and 2nd, as soon as the temperature of the dust particle reaches, in its cooling, the dew point of the air in contact with it, dew begins to be deposited on it, and the vitally important result follows that a portion of the aqueous vapour of the atmosphere passes from the gaseous to the liquid state, thus reducing the tension. Hence the morning minimum is due to a reduction of tension brought about by a comparatively sudden lowering of the temperature of the air itself and by a change of a portion of the aqueous vapour from the gaseous to the liquid state. Since this takes place at a more rapid rate than is compensated for by any mechanical or tidal movement of the atmosphere from the regions adjoining, owing to the inertia and viscosity of the air, pressure continues to fall to the morning minimum, which occurs some time before sunrise, or rather before dawn. It is probable that the commencement of the increase from the minimum before the air is yet heated by the indirect or direct rays of the returning sun is due to the setting in of a mechanical or tidal movement of the contiguous air towards this region where the pressure has been lowered. The morning minimum is thus due, not to any removal of the mass of air overhead, but to a reduc-

tion of the tension by a lowering of the temperature and change of state of a part of the aqueous vapour.

The Morning Maximum.—The diurnal heating of the atmosphere proceeds with the ascent of the sun. As the water condensed on the surfaces of the dust particles is evaporated, tension is increased by the simple change from the fluid to the gaseous state; and as the dust particles in the sun's rays rise in temperature above that of the films of air in contact with them, the temperature of the atmosphere is thereby raised, thus further increasing the tension. Under these conditions the barometer steadily rises with the increasing tension to the morning maximum. It is to be particularly noted that this rise of the barometer is not due to any accessions to the mass of air overhead, but only to increasing temperature and change of part of the watery vapour from the liquid to the gaseous state. Owing to the rapidity of the heating and increase of tension of the atmosphere through its whole height by the sun's rays, but more particularly in the lowermost strata where the dust particles are more numerous and, as the colours of sunset suggest, grosser than prevail in the upper regions of the atmosphere, some time must elapse before the greater expansive force thus called into play is able to counteract the vertical and lateral resistance it meets from the inertia and viscosity of the air. The only effect of the conversion of latent to sensible heat in these condensations, and the converse after sunrise, is but a slight retardation of the phenomena.

The Afternoon Minimum.—When this resistance has been overcome, an ascending current of the warm air sets in, and pressure gradually falls, as the mass of air overhead is reduced by the ascending current flowing back as an upper current to eastward, in other words, over the section of the atmosphere immediately to eastward, the temperature of which has now fallen considerably lower than that of the region from which the ascending current rises.

The Evening Maximum.—When the daily maximum temperature is past and temperature has begun to fall, the air becomes gradually more condensed in the lower strata, and, as a consequence, pressure at great heights is lowered, and, be it particularly noted, lowered most as compared with the pressure at the same height over the region from which the ascending current is rising. Hence it follows that owing to this relative difference of pressure, the ascending current, which rises from the longitudes where at the time the afternoon pressure is at the minimum, flows back to eastward, thus increasing the pressure over those longitudes where temperature has now greatly fallen. This atmospheric quasi-tidal movement occasions the evening maximum of pressure, which occurs from 9 P.M. to midnight, according to latitude and geographical position. As midnight and the early hours of morning advance, these contributions through the upper currents become less and less, and finally cease altogether, and the effects of the nocturnal radiation now going forward again introduce the morning minimum, as already described. Thus the afternoon minimum is occasioned by the removal of part of the mass of the atmosphere by the ascending current and its connected upper current,

and the evening maximum by accessions to the mass of atmosphere overhead from this upper current.

The Challenger observations all show that over the ocean, latitude for latitude, the amplitude of the oscillations is larger in an atmosphere highly charged with aqueous vapour, and less in a dry atmosphere. Also over the open sea, the morning minimum is largest in equatorial regions, and it diminishes with latitude; but its rate of diminution with latitude through anticyclonic and other regions is generally less and more uniform than is the case with the afternoon minimum.

From October 12 to 22, 1875, the mean pressure in lat. 35° 1′ S. and long. 134° 35′ W. was 30·298 inches, and the difference between the morning maximum and the afternoon minimum was only 0·036 inch; again, from July 12 to 19 in the same year, in lat. 36° 16′ N. and long. 156° 11′ W., the mean pressure was 30·328 inches, and the difference between the A.M. maximum and the P.M. minimum was only 0·025 inch. Thus in the Pacific about lat. 35°–36° N. and S., with a mean pressure much greater than near the equator, the oscillation is much less, being in the North Pacific less than a third of what occurs near the equator. In the same latitudes in the middle of the South Atlantic the difference was observed to be 0·025 inch, and in the North Atlantic 0·014 inch. Now these are regions of the four great oceans which are overspread by permanent anticyclones, and characterised by calms, light and variable winds, and the central regions of which are as a matter of fact but little traversed by sailors, as is well shown on Baillie's Meteorological Charts of the Oceans. These regions are shown on the Isobaric maps, and it will be seen that the surface winds outflow in every direction from the high pressure areas of the anticyclones. Since, notwithstanding the outflow of the surface, pressure remains high, it necessarily follows that the high pressure is kept up by an inflow of upper currents. As the slow descending air of the centre of the anticyclones connects the inflowing upper currents with the outflowing winds of the surface, it follows that the air filling the central areas of the anticyclones is relatively very dry,—every stage of its descent adding to its relative dryness,—and contains in all probability fewer dust particles than elsewhere. Hence over anticyclonic areas the atmosphere will be less cooled by nocturnal radiation and less heated by solar radiation, and the change of the aqueous vapour from the gaseous to the liquid state and *vice versa* will be also less than elsewhere. It follows that the amplitudes of the oscillation will diminish as the ocean becomes more land-locked with continents, in other words, as the anticyclonic region becomes better defined and currents of air, which rise from the heated surfaces of the adjoining continents, are poured down more steadily and copiously by the upper currents of the atmosphere. Hence of the four oceans, the smallest oscillation, 0·014 inch, is shown in the anticyclonic region of the North Atlantic, and the largest, 0·036 inch, in that of the South Pacific.

The geographical distribution of this oscillation is given in the accompanying Fig. 2, which shows for July its amount by lines of 10, 20, 40, 60, 80, and 100 thousandths of

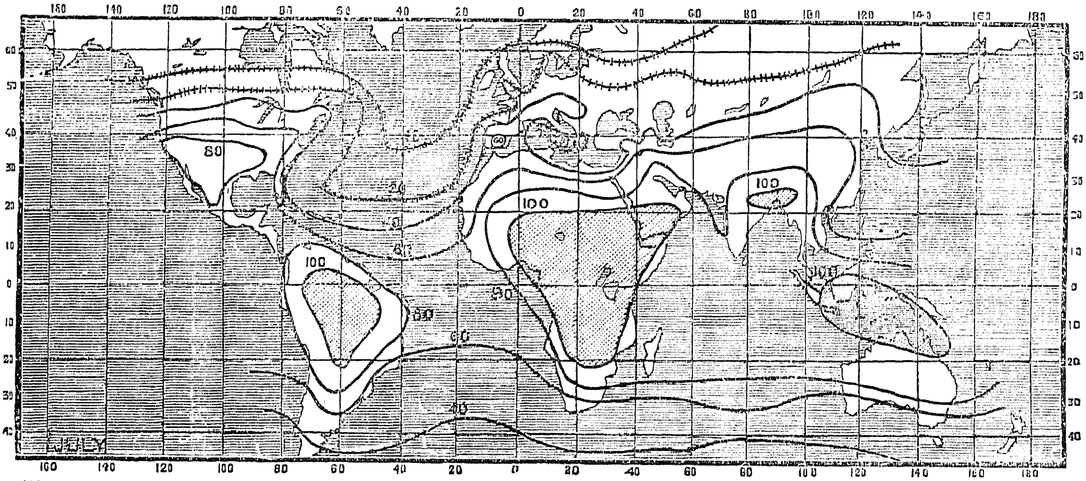


Fig. 2.—Chart showing the mean monthly amount of the diurnal oscillation of the barometer over the globe for July.

an inch, or 0·010 inch, 0·020 inch, etc. The abnormally small amount over the centre of the Atlantic and the Mediterranean begins in March, attains the maximum in June, and ends in October. It is thus confined to the warmer months of the year, and is not cumulative, like most other meteorological phenomena, but follows the sun, having its maximum in June. The smallness of the oscillation over the North Atlantic, which is probably less than occurs in any other ocean in the same latitude, is to a large extent caused by the small dip in the diurnal curve of the afternoon minimum, thus indicating an atmosphere where the heating by the sun is comparatively small. Over the open sea of the higher latitudes, the afternoon dip, or afternoon minimum, disappears, thus reducing the barometric curve to one maximum and one minimum during the twenty-four hours.

The much greater amplitude of the oscillations on land, as compared with the open sea, is entirely due to the heating of the surface of the earth, this higher temperature, which has its origin in the superheated surface, being in addition to the direct heating of the air by the heat rays of the sun as they pass through it. Tension is thereby still further increased, and, consequently, the morning maximum and the afternoon minimum are both more extreme than over the open sea. The oscillation reaches its maximum just in those tropical climates where insolation is strongest, and the effect is doubtless still further heightened by the greater number of dust particles present in the atmosphere of these climates.

In low latitudes, where the velocity of the surface due to the earth's rotation is near the maximum, the four phases of the barometric oscillations are most sharply defined and of greatest amplitude. But in the higher latitudes, where the velocity of the surface is much reduced, the amount of the oscillation is also small, and the one phase passes into the other by easy gradations.

It has been shown in the Table, p. 13, that in situations more or less insular

situated to westward of a pretty extensive tract of land, the forenoon maximum is retarded,—in some places as much as seven hours,—and that in all these cases the afternoon minimum is small and in some instances all but disappears. On the other hand, at no great distance from the coast, both inland and seaward, the afternoon minimum is quite distinctly seen, the retardation of the forenoon maximum rapidly gives way, and the chief phases of the diurnal oscillation occur near the normal times. This disturbance in the diurnal oscillation can scarcely be said to occur on the east coasts of tracts of land.

This peculiarity of the diurnal barometric tide is due to the circumstance that the air over the land is earlier and more rapidly heated than the air over the sea to westward of it, and, consequently, the ascending current sets in sooner and stronger over the land than over the sea, accompanied with the necessary result of the propagation of a temporary overflow to westward by a sub-upper current from the continental toward the insular situation. The retardation of the phases of the curve is also seen in lower latitudes, though less easily detected owing to the larger amounts of the oscillations. In summer, at Coimbra, pressure falls to the mean of the day shortly after noon, but at Lisbon it is an hour and at San Fernando an hour and a half later. At Milan it occurs about 12.45 P.M., but at Naples it is delayed to about 3 P.M.

The following Table presents another set of diurnal barometric curves totally different from any yet referred to. It gives in thousandths of an inch, the winter, summer, and annual means for Gries, Klagenfurt, and Cordova, to which Mexico is added.

	Gries, Lat. 46° 30′, Long. 11° 20′; Height, 958 Feet.			Klagenfurt, Lat. 46° 37′, Long. 14° 18′; Height, 1437 Feet.			Cordova, Lat. −31° 24′, Long. −64° 6′; 1460 Feet.			Mexico, Lat. 19° 26′, Long. −99° 0′; 7490 Feet.		
	Nov., Dec., Jan.	May, June, July.	Year.	Nov., Dec., Jan.	May, June, July.	Year.	May, June, July.	Nov., Dec., Jan.	Year.	Nov., Dec., Jan.	May, June, July.	Year.
1 A.M.	8	25	18	11	15	14	24	24	26	10	10	10
2 ,,	7	25	18	9	16	13	23	23	25	3	1	2
3 ,,	7	24	17	9	16	13	21	21	23	1	*2*	*2*
4 ,,	3	28	16	9	18	13	19	21	22	2	*0*	*0*
5 ,,	1	34	18	9	22	14	18	24	22	7	7	7
6 ,,	1	40	22	10	25	11	17	30	24	19	18	19
7 ,,	5	40	26	13	24	20	18	36	28	32	29	31
8 ,,	14	35	30	16	26	21	20	41	31	47	35	41
9 ,,	19	28	29	14	19	19	23	40	33	56	37	47
10 ,,	19	15	21	12	15	15	25	34	30	49	30	41
11 ,,	15	2	11	4	5	6	14	25	20	30	18	26
Noon	0	*15*	*6*	*6*	*5*	*4*	*4*	15	5	1	3	4
1 P.M.	*14*	*35*	*23*	*18*	*18*	*16*	*24*	*2*	*14*	*27*	*23*	*23*
2 ,,	*25*	*45*	*37*	*24*	*29*	*27*	*41*	*14*	*32*	*51*	*34*	*43*
3 ,,	*28*	*54*	*45*	*27*	*36*	*32*	*47*	*40*	*47*	*63*	*52*	*57*
4 ,,	*26*	*58*	*48*	*25*	*41*	*35*	*46*	*56*	*54*	*63*	*58*	*62*
5 ,,	*22*	*57*	*46*	*20*	*42*	*33*	*40*	*61*	*53*	*54*	*54*	*57*
6 ,,	*12*	*47*	*36*	*13*	*36*	*27*	*32*	*60*	*48*	*44*	*39*	*43*
7 ,,	*6*	*35*	*24*	*8*	*27*	*18*	*22*	*55*	*40*	*19*	*22*	*24*
8 ,,	1	*14*	*9*	*1*	*14*	*7*	*11*	*45*	*28*	*3*	*2*	*2*
9 ,,	4	4	3	5	3	4	*1*	*26*	*14*	16	13	16
10 ,,	9	14	11	7	8	8	10	*6*	2	21	25	24
11 ,,	10	21	15	8	12	10	20	13	17	19	28	24
Midnight	11	25	19	8	16	13	23	22	23	16	21	19

The most noticeable feature of these daily barometric oscillations is their very large amounts, those at Gries, though in lat. 46° 30′ N., being tropical in amount; and the singular circumstance is that in no season does the morning minimum fall so low as the daily mean. Gries, Klagenfurt, and Cordova are each situated in a deep valley, and they present the diurnal barometric curves characteristic of these places (Plate I. fig. 20). In such situations, during night, the whole surface of the region is cooled by radiation below the air above it, and the air in immediate contact with the ground becoming also cooled, a system of descending air-currents sets in over the whole face of the country bounding the deep valley. The direction and velocity of these descending currents are modified by the irregularities of the ground, and, like currents of water, they converge in the bottom of the valleys, which they fill to a considerable height with the cold air they bring down from the sides of the mountains. This cold and consequently relatively dense air rises above the barometers which happen to be down in the valley, with the result that a high mean pressure is maintained during the night. In summer the pressure at the coldest time of the night is maintained, 0·020 inch, at Klagenfurt, higher than it is in open situations in that country, and double this amount, or 0·040 inch, at Gries. On the other hand, during the day these deep valleys become highly heated by the sun, and a strong ascending current is early formed, under which pressure falls unusually low. Thus, while at Vienna the afternoon minimum falls 0·026 inch below the daily mean, at Klagenfurt the amount is 0·042 inch, and at Gries 0·058 inch.

The same feature of the pressure is seen, though in a much less pronounced degree, in the curves for Mexico, where the daily range is usually large for so elevated a station and consequent low mean pressure, and where the morning minimum either does not fall to the mean of the day or but little below it.

On the other hand, at high-level observatories, such as Obirgipfel and Ben Nevis, which are situated on true peaks, the daily curve of pressure is wholly different (Plate I. fig. 21). In these situations the curves all show an abnormally large morning minimum, and, in summer more particularly, an afternoon minimum so small as all but wholly to disappear.

It follows that the diurnal curves of atmospheric pressure are liable to large modifications according as the earth's surface, in the more immediate neighbourhood of the barometer from which the observations are made, presents a level plain, a troughed hollow between mountains or rising grounds, or an isolated peak.

In high latitudes, in the interior of continents, when there is either constant sunshine, or sunshine and a strongly pronounced twilight, the morning minimum is much reduced, and in the height of summer vanishes altogether, being probably the effect of the short nights, the comparatively slow motion from the earth's rotation, and the constant heating from the sun's rays, direct or indirect. The summer curve for

Fort Rae, lat. 62° 39′ N., long. 115° 44′ W., illustrates this peculiarity of the diurnal pressure (Plate I. fig. 15).

Over the ocean in high latitudes the diurnal curves of pressure show only one maximum and one minimum, but the times of their occurrence are directly opposite to those over land.

It is evident that in employing the data of Table IV. in "correcting" for daily range, with the view of bringing the observations to the true daily mean pressure, the greatest care is required in selecting stations whose means will give approximately true "corrections." Indeed, as regards narrow steep valleys, any such attempted reductions can at best only be regarded as useless.

The daily oscillations of pressure at places given in Table IV. show the same feature to be apparent even in comparatively shallow valleys bounded by distant rising grounds with low surface gradients. This consideration must not be lost sight of in any effort to trace the simple temperature effect on the daily barometric tides. In truth, the observed temperatures made at the station can be used in such a discussion only when the observations are made on the open sea, or on what is substantially an open plain at some distance from the sea. On coasts, in comparatively narrow valleys, but in a less degree on peaks, the problem becomes very complicated, and in attempting to solve it the temperature of the region for some distance round the place of observation must also be taken into account.

Towards the end of Table IV. are given the diurnal ranges for Polar Stations, including nearly the whole of the International Arctic and Antarctic Stations during 1882 and 1883. An examination of these is sufficient to show that several results must be accepted with some reserve as a representation of the facts of the diurnal variation of pressure in these higher latitudes. More might have been made of these observations if they had been published as made, that is, if, instead of reducing to 32°, by the methods in common use, the original readings of the barometer and of the attached thermometer had been printed. Since the daily range in these regions is very small, probably not exceeding 0·010 inch, and since in every case when the temperature shown by the attached thermometer differs from that of the barometer taken as a whole, it follows that for every degree of difference the reduced observations contain an error of about 0·003 inch. Indeed, the hourly pressures at several Arctic Stations, instead of showing the horary changes of pressure, appear in some cases to indicate in an obscure way the changes of temperature, artificial or otherwise, of the apartment where the barometer was hung. In those cases where care has been taken to secure that the monthly means of the attached thermometers, for the different hours of the day, represent the temperature of the whole barometer to within a degree, the results show the extension of the oscillations into Arctic and Antarctic regions. They are probably dependent on the diurnal changes in the temperature of the air itself, irrespective of those of the earth's surface, and they may be, in some way, influenced by quasi-tidal movements from lower latitudes.

Variation of the Force of the Wind.—During the cruise of the Challenger, observations of the force of the wind were made on 1202 days, at least twelve times daily, 650 of the days being on the open sea, and 552 near land. The observations were on Beaufort's scale 0–12, being the scale of wind force observed at sea. The results showing the hourly variations in the force of the wind are given in the following table, where the observations have been grouped according to the five oceans in which they were made, viz.: the North Atlantic, the South Atlantic, the North Pacific, the South Pacific, and the Southern Ocean:—

	N. Atlantic.		S. Atlantic.		N. Pacific.		S. Pacific.		Southern Ocean.		Mean.	
	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.	Open Sea.	Near Land.
No. of Obs. .	192	91	87	75	142	165	156	163	73	58	650	552
2 A.M. . .	2·96	2·27	3·10	2·26	2·59	1·31	2·67	1·34	4·40	2·26	2·98	1·72
4 „ . . .	3·00	2·30	3·14	2·03	2·34	1·20	2·65	1·39	4·07	2·28	2·90	1·67
6 „ . . .	2·95	2·23	3·05	2·14	2·22	1·14	2·62	1·27	4·04	2·60	2·85	1·66
8 „ . . .	2·94	2·23	2·90	2·12	2·28	1·09	2·71	1·37	3·82	2·93	2·83	1·69
10 „ . . .	3·12	2·55	3·01	2·40	2·21	1·27	2·68	1·76	3·96	3·28	2·87	2·01
Noon . . .	3·08	2·55	2·97	2·57	2·34	1·65	2·78	2·14	4·03	3·52	2·92	2·27
2 P.M. . .	3·07	2·82	3·06	2·68	2·37	1·67	2·59	2·13	4·20	3·57	2·92	2·36
4 „ . . .	2·97	2·74	3·13	2·61	2·27	1·71	2·58	2·08	4·26	3·49	2·87	2·30
6 „ . . .	2·95	2·48	3·12	2·60	2·28	1·37	2·64	1·69	4·06	3·44	2·87	2·08
8 „ . . .	2·94	2·27	3·21	2·34	2·26	1·13	2·66	1·35	4·00	2·87	2·85	1·76
10 „ . . .	3·01	2·17	3·25	2·27	2·39	1·15	2·60	1·37	4·16	2·40	2·92	1·68
Midnight . .	2·96	2·23	3·16	2·18	2·27	1·32	2·61	1·43	4·16	2·40	2·87	1·75
Means . . .	3·00	2·40	3·09	2·35	2·32	1·33	2·65	1·61	4·10	2·92	2·89	1·91
Means (miles)	18	15	18½	15	15	10	16	11	23	18	17	13

Thus the velocity of the wind is greater over the open sea than on or near land, the mean difference being from four to five miles per hour. Of the five oceans, the velocity is greatest over the Southern Ocean, and least over the North Pacific, the difference being eight miles per hour. In the part of the cruise embracing the Southern Ocean, the Challenger crossed and re-crossed the "roaring forties," and hence probably the higher observed velocity of the wind over this ocean.

With respect to the open sea, it is evident from the mean curve for the five oceans (Plate II. fig. 22) that the diurnal variation is very small, there being apparently two indistinctly marked maxima about midday and midnight respectively. But on examining the separate means of each of the five oceans, there appears to be no uniform agreement observable among their curves, the slight variations being different in each case. Looking at the curves in connection with the number of observations from which each has been drawn, it seems probable that the line representing the true diurnal variation in the velocity of the wind is practically a uniform straight line, with the single exception of a small rise about midday, not quite amounting to a mile per hour.

But as regards the winds recorded by the Challenger when near land, the velocity at the different hours of the day gives a curve, for the five oceans combined, as clearly and decidedly marked as the diurnal curve of temperature (Plate II. fig. 23). The minimum occurs from 2 to 4 A.M., and the maximum from noon to 4 P.M., the absolute highest being at 2 P.M. The curves for each of the five oceans give one and the same result, viz., a curve closely accordant with the diurnal curve of temperature. The differences between the hour of least and that of greatest velocity are, for the Southern Ocean, $6\frac{1}{2}$ miles; South Pacific, $4\frac{1}{2}$ miles; South Atlantic, $3\frac{1}{4}$ miles; North Atlantic and North Pacific, 3 miles per hour.

In the case of each ocean, the velocity of the wind over the open sea is considerably in excess of that near land, and it is noteworthy that in no case does the maximum velocity near land, attained near noon, reach the velocity over the open sea. The nearest approach, at any hour of the day, of the maximum velocity near land to the velocity over the open sea at the same hour is in the North Atlantic, 2·5; South Atlantic, 3·8; North and South Pacific, each 4·6; Southern Ocean, 5·1; and the mean of all the oceans, 5·6. The difference is greatest at 4 A.M., when it is about 6 miles an hour, but diminishes as temperature rises, till at 2 P.M. it is less than 3 miles an hour.

On land the diurnal variation in the wind's velocity becomes more pronounced. At Batavia the minimum occurs in all months in the early morning, when the temperature is lowest, and the maximum from 1 to 3 P.M., the minimum and maximum velocities being to each other as 1 to 21. At Mauritius the minimum, occurring from 2 to 3 A.M., is nearly 9·7 miles an hour, and the maximum 18·5 miles from 1 to 2 P.M. At Coimbra the maximum is five times greater than the minimum velocity in summer, but in winter it is only about a half more. At Valentia, in the south-west of Ireland, the minimum is 10 miles an hour at 11 P.M., and the maximum 18 miles at 1 P.M.

From a discussion of a number of places in northern Europe, Hann has shown that the velocity is doubled from the minimum with a completely clear sky, three-fourths greater with a sky half-covered, but with a sky wholly covered it is only one-half more. At the strictly continental situation of Vienna, with a clear sky the velocity is doubled, with a sky half-covered it is two-thirds greater, but when the sky is quite covered the variation in the wind's velocity becomes irregular and faintly marked. This last result, and the fact that the time of maximum velocity is not coincident with that of the highest air-temperature, but shortly after midday, when insolation is strongest, and the fact of no variation occurring over the open sea, point to the conclusion that the diurnal variation is a consequence of the diurnal variations which take place in the temperature of the earth's surface over which the winds blow.

There is another class of observations which form a valuable contribution to this

question, viz., the observations recently obtained from such high-level observatories as are situated on true peaks, as Ben Nevis, Säntis, Obirgipfel, Sonnblich, etc. In such situations, the curve of diurnal variation in the wind's velocity is precisely the reverse of what obtains over what are substantially plains or plateaux. At these high-level observatories the maximum hourly velocity occurs during the night and the minimum during the day.

Reference has been made to the high barometer maintained in deep narrow valleys during the night, as being the result of the cold currents from the adjoining slopes which the chilling effects of terrestrial radiation set in motion. These masses of cold air, accumulated in the valleys, give rise to the well-known furious blasts of wind blowing down the valleys of such mountainous regions as the Alps during clear and comparatively calm nights. Now since these down-rushing winds must necessarily be fed from higher levels than those of the mountain itself, it follows that the winds prevailing on the peak of the mountain are really the winds of a higher level, and blow therefore with the greater velocity due to that greater height; and the increased velocity is kept up as long as the cold currents occasioned by terrestrial radiation continue to be poured down to the bottom of the valleys. This consideration serves to explain the apparently anomalous direction of the winds in Greenland, which are in some degree modified by the downflow from the adjoining high grounds.

On the other hand, during the warmer hours of the day, the barometric pressure of deep valleys is, as has been shown, abnormally low, owing to the super-heating of these valleys, as contrasted with the temperature of the surrounding region. This gives rise to a warm wind blowing up the valleys during the hottest hours of the day, and an ascending current close to the sides of the mountain up to the very summit. Now since no inconsiderable portion of this ascending current, whose horizontal velocity is necessarily much retarded, mingles with the air-current proper to the level of the peak, it follows that the prevailing wind on the peak must be retarded during the hottest hours of the day.

The explanation of the variation of the wind's velocity over comparatively flat surfaces is more difficult. Whatever be the cause or causes, they are intimately, if not immediately, connected with the temperature of the earth's surface over which the winds blow. The Challenger observations on the five great oceans prove that, so far as concerns any direct influence on the air itself, solar and terrestrial radiation exercise no influence on the diurnal variation in the velocity of the wind, these showing practically no variation in the velocity. The same observations prove that on nearing land the velocity of the wind is everywhere reduced, but that the retardation is greatest during those hours of the day when the temperature is lowest, and least when the temperature is highest. The time of the day when the wind's velocity is increased is practically limited to the hours when temperature is above the daily

mean, and the influence of the higher temperature is, in some degree, to counteract the retardation of the wind's velocity resulting from friction and from the viscosity of the air encountered near land.

An explanation not unfrequently adduced is that the variation is due to the ascending currents with their reduced velocities, and the descending currents with their increased velocities, which set in as the necessary result of the unequal heating of the surface at different hours of the day. Now if this were so, the increased velocity during the hottest hours of the day would be closely congruent with the diurnal curve of atmospheric pressure, commencing with the time when pressure begins to fall from the morning maximum, in other words, from the time the ascending current sets in, and would reach the maximum at the hour of the afternoon minimum of pressure, that is, the time when the ascensional current is strongest. Observation does not bear this out, since the increase in the diurnal velocity sets in before pressure begins to fall from the morning maximum; and the maximum, in the summer months when the whole phenomena are most pronounced, occurs from two to four hours before the time of the afternoon minimum of pressure. The time of occurrence of the maximum velocity is from 1 to 2 P.M., or when the diurnal insolation is strongest. Observations thus point to the conclusion that, while ascensional and descensional currents play a part in bringing about the diurnal variation, by far the more important part is due to the difference between the temperature of the earth's surface and that of the wind blowing over it at the moment. It is evident that when the surface of the ground is superheated, and an ascensional movement of the air has set in from the heated surface, the retardation of the wind's velocity, resulting from friction and from the viscosity of the air, is more or less counteracted, and the velocity of the wind is thereby increased. On the other hand, during the night, when terrestrial radiation is proceeding, the temperature of the surface rapidly falls, all ascensional movement ceases and gives way to a descensional movement of the lowermost stratum of the air down the slopes of the country, with the result that during these hours the retardation of the wind's velocity from friction is greatest.

Variation in the Amount of Cloud.—The diurnal variation in the amount of cloud in the sky over the open sea is very small. The following are the means of 277 days' observations on board the Challenger, stated in percentages of sky covered with clouds:—

2 A.M.,	59	2 P.M.,	58
4 „	59	4 „	59
6 „	62	6 „	57
8 „	62	8 „	57
10 „	58	10 „	57
Noon,	56	Midnight,	57

Two maxima are here indicated, the one about or shortly after sunrise, and the other in the early part of the afternoon; and two minima, the one at noon and the other from sunset to midnight. But the difference between the daily extremes is only 6 per cent. of the sky. The diurnal variations in the amount of cloud are among the less satisfactorily observed phenomena of meteorology. From what has been done, however, a few general deductions may be made. A maximum occurs in the morning and continues till a little after sunrise, and this maximum is more pronounced over the open sea than over land. Its appearance may be regarded as due to the general cooling of the atmosphere through its whole height by terrestrial radiation, and its disappearance by the heating of the air by the returning sun. The first of the two minima extends from this time to about noon, this relatively greater clearness of sky occurring thus while temperature is most rapidly increasing and before the ascending current has set in in any considerable volume. The period of this ascending current, or the time of the afternoon minimum of atmospheric pressure, marks the afternoon maximum of cloud, which over the land surfaces of the globe is much larger than the morning maximum, being thus the reverse of what the Challenger observations disclose.

Of this maximum the cumulus is the characteristic cloud. These are but the summits of the ascending currents that rise from the heated land, in which the aqueous vapour is condensed into cloud during the expansion and consequent cooling that takes place with increase of height. Cumulus clouds cast an instructive light on the behaviour of the ascending currents rising from the more highly-heated lowermost strata of the atmosphere, inasmuch as they indicate that the current ascending from the surface is broken up into subdivisions that are thereafter grouped into separate well-defined ascending currents, each of which is marked off and topped by the cumulus cloud. It is highly probable, considering the clearly-defined positions of these clouds, that the air composing the ascending currents is not only warmer but that it is also moister than the air in and beneath the clear interspaces; and, further, it may be regarded as probable that it is down through these clear interspaces that the descending air filaments shape their course in their way downwards to take the place of the air molecules that ascend from the heated surface of the earth.

The secondary minimum of cloud occurs from about sunset onwards during the time occupied by the evening maximum of atmospheric pressure. The frequent dissolving and final disappearance of cloud from about sunset onwards as the evening advances is familiar to all, occurring in those types of weather, principally, when the evening maximum of pressure for the day is most distinctly marked.

It is to be noted here that in a highly-saturated atmosphere, which is so characteristic a feature of many tropical climates at certain seasons, this time of the day is remarkable for the amount of cloud; and it is in those seasons, and during those hours, that heat-lightning, or lightning without thunder, attains its annual

maximum period, and also its diurnal maximum period, which is from six to eight hours later than that of thunderstorms.

Variation in the Amount of the Rainfall.—During the cruise every instance of precipitation,—rain specified as passing showers or continued rain, drizzle, sleet, or snow,—were recorded in their place of occurrence among the two-hourly observations. These have been tabulated and summed up, with the following result:—

	Rain. Over open Sea.	Rain. Near Land.	Rain. Total.
2 A.M.,	130	87	217
4 "	118	90	208
6 "	117	75	192
8 "	115	75	190
10 "	113	82	195
Noon,	110	79	189
2 P.M.	103	75	178
4 P.M.,	95	71	166
6 "	101	74	175
8 "	113	82	195
10 "	114	79	193
Midnight,	112	83	195
Total,	1341	952	2293

These figures show (Plate II. fig. 24) that, as regards the occurrence of rain over the open sea during the day, there is one maximum of 130 instances at 2 A.M., and one minimum of 95 instances at 4 P.M.; and that, while for the twelve hours ending 8 A.M. the number of cases was 706, for the twelve hours ending 8 P.M. the number was 635. Hence the frequency of occurrence of rain over the open sea is simply inversely as the temperature. Near land the distribution of rain during the twenty-four hours is different, the results showing two maxima and two minima, the secondary maximum occurring from 10 A.M. to 2 P.M., the two maximum periods being the times of maximum and minimum temperature, and the two minima the early morning and early evening respectively.

Dr. Bergsma has shown, from sixteen years' observation made at Batavia, the diurnal variation at that place, of which the following are the percentages of the daily amount which fell every two hours:—

Midnight to 2 A.M.,	8·7
2 A.M. " 4 "	6·4
4 " " 6 "	6·1
6 " " 8 "	5·2
8 " " 10 "	5·5
10 " " noon,	6·3
Noon to 2 P.M.,	9·5
2 P.M. " 4 "	12·2
4 " " 6 "	13·5
6 " " 8 "	10·5
8 " " 10 "	7·4
10 " " midnight,	8·7

It will be observed that this curve is the reverse of the curve for the open sea,

while the curve for the observations made near land partakes of the character of both curves. Much yet requires to be done in collecting the suitable data of observation for a proper treatment of the question of the diurnal curves of the rainfall of different climates. Such data, however, so far as collected, show the general occurrence of a maximum from about 11 A.M. to 6 P.M., and this peculiarity of the curve is a particularly outstanding feature of the curves of continental climates during the summer months of the year, when thunderstorms have their maximum annual occurrence. A marked diminution of the rainfall is generally observed from about sunset to midnight, or during the hours when, in many climates, the amount of cloud falls to the minimum, and the evening maximum of pressure takes place. The time of the morning minimum of pressure, from about 2 to 6 A.M., is, curiously, in many places strongly marked as a maximum, whereas in others it is equally strongly marked as a minimum, of which the Challenger and Batavia curves may be taken as typical examples.

Variation of Thunderstorms. — The following table shows the distribution through the hours of the day of the cases of occurrence during the cruise—(1) of thunderstorms or thunder with lightning, and (2) of lightning alone :—

	Thunderstorms.			Lightning only.		Thunderstorms.			Lightning only.
	Open Sea.	Near Land.	Total.			Open Sea.	Near Land.	Total.	
Midnight to 2 A.M.	4	2	6	42	2 P.M. to 4 P.M.	2	2	4	2
2 A.M. ,, 4 ,,	7	2	9	36	4 ,, ,, 6 ,,	0	1	1	7
4 ,, ,, 6 ,,	5	0	5	11	6 ,, ,, 8 ,,	0	2	2	25
6 ,, ,, 8 ,,	3	2	5	0	8 ,, ,, 10 ,,	1	2	3	46
8 ,, ,, 10 ,,	1	2	3	0	10 ,, ,, midnight	3	3	6	39
10 ,, ,, noon	0	0	0	0					
Noon ,, 2 P.M.	0	1	1	1	Total	26	19	45	209

Of the 45 thunderstorms recorded, 26 occurred over the open sea, and 19 near land. Of those recorded over the open sea 22 occurred during the ten hours from 10 P.M. to 8 A.M., whereas during the other fourteen hours of the day only 4 occurred (Plate II. fig. 25). Hence the important conclusion that over the open sea thunderstorms are essentially phenomena of the night, and occur chiefly during the morning minimum of pressure. On the other hand, as regards the thunderstorms which occurred near land, they are pretty evenly distributed during the twenty-four hours.

Over land, but especially where the climate is more or less continental in its character, the distribution of thunderstorms during the day is the reverse of the above. The following table shows the number of (1) thunderstorms, and (2) lightning only,

recorded at Oxford during twenty-four years, for the seven months from April to October, of which months August is represented on Plate II. figs. 26 and 27 :—

	Thunderstorms.								Lightning only.							
Hour ending	April.	May.	June.	July.	Aug.	Sept.	Oct.	Total.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Total.
1 A.M. .	1	2	6	3	2	0	0	14	0	2	1	3	4	2	0	12
2 ,, . .	2	1	1	1	1	0	1	7	0	0	0	0	3	2	0	5
3 ,, . .	1	2	3	2	1	0	2	11	0	0	0	0	0	1	0	1
4 ,, . .	0	1	4	3	0	1	1	10	0	0	0	0	0	0	0	0
5 ,, . .	0	3	3	2	2	1	1	12	0	0	0	0	0	0	0	0
6 ,, . .	0	2	3	6	1	3	1	16	0	0	0	0	0	0	2	2
7 ,, . .	1	1	2	2	0	1	0	7	0	0	0	0	0	2	1	3
8 ,, . .	0	1	2	3	0	1	0	7	0	2	1	0	0	4	1	8
9 ,, . .	0	1	2	4	1	1	0	9	0	0	2	0	0	3	5	10
10 ,, . .	0	1	4	2	1	1	0	9	0	0	1	4	1	3	1	10
11 ,, . .	0	2	3	2	1	0	0	8	0	0	0	1	0	1	1	3
Noon . .	3	7	6	3	4	1	0	24	0	0	0	0	0	1	1	2
1 P.M. .	0	5	5	6	8	7	3	34	0	0	0	0	0	1	0	1
2 ,, . .	1	5	5	1	7	7	1	25	0	0	0	0	2	2	0	4
3 ,, . .	2	8	6	7	7	3	0	33	0	0	0	1	2	2	0	5
4 ,, . .	2	6	9	7	8	5	2	38	0	0	0	0	2	2	0	4
5 ,, . .	3	5	5	7	4	3	0	27	0	0	0	0	2	0	1	3
6 ,, . .	1	5	4	7	6	5	0	28	0	0	0	1	3	3	5	12
7 ,, . .	1	2	4	0	6	4	0	17	0	1	0	0	2	3	12	18
8 ,, . .	1	2	2	0	3	1	0	9	2	2	2	1	5	8	4	24
9 ,, . .	1	3	2	3	4	2	0	15	0	2	2	4	11	6	7	32
10 ,, . .	1	3	1	1	3	3	0	12	0	3	3	11	18	5	4	44
11 ,, . .	1	1	3	1	2	2	1	11	1	3	2	10	15	4	2	37
Midnight	1	2	4	4	2	2	0	15	1	2	4	9	12	4	1	33
Total . .	23	69	89	77	74	54	13	399	4	17	18	45	82	59	48	273

During the other five months of the year electrical displays are infrequent. As these figures for Oxford may be accepted as typical of the distribution of thunderstorms during the day, and the times of the maxima and minima over the land surfaces of the globe at some distance from the sea-coast, it is evident that the diurnal maximum occurs in the afternoon, and is substantially coincident with the afternoon minimum of atmospheric pressure; whilst on the other hand, the maximum over the open sea is closely coincident with the morning minimum of pressure. Over the land the maximum of thunderstorms occurs during the hours of the day when temperature is highest, but over the open sea during those hours when temperature is lowest. The great majority of thunderstorms over the land thus occur during the part of the day when the ascensional movement of the air from the heated surface of the ground takes place, and they reach the maximum when the temperature and this upward movement are also at the maximum. It thus appears that ascending currents and their necessary accompaniment, descending currents in the atmosphere, play an important part in the history of thunderstorms.

In places where the climate is dry and rainless, like that of Jerusalem in the

summer months, thunder is quite unknown; and places such as Coimbra and Lisbon, where the summer rainfall is small and its occurrence rare, thunderstorms become less frequent, and the hours of their occurrence become later than before and after the dry season. Further, when during a particular season an anticyclone, with its great descending current in the centre, remains over a region, as happens in the centre of the old Continent during winter, thunder is equally unknown.

In this connection much interest is attached to the thunderstorms of Mauritius, arising from its isolated position in a vast ocean, and its relations to the great movements of the atmosphere in that part of the globe. In this island there are two maxima in the diurnal curve, the larger of the two occurring from noon to 4 P.M., and the smaller from 3 to 6 A.M., these being the times of the two barometric minima, or the times of maximum occurrence from the Challenger observations over the open sea and inland at Oxford; and two times of minimum occurrence, from 9 P.M. to 1 A.M. and from 8 to 10 A.M., these being near the times of the barometric maxima. Another important fact, as regards the thunderstorms of Mauritius, is, that during twelve years none were recorded in June and July, one in August, one in September, and three in October. Observations show that the annual period of thunderstorms is the seven months from near the end of October to the middle of May, or during the time of the greatest rainfall, while practically none occur during the other five months. In these five months rain, however, continues to fall, amounting to an average of about two inches each month. Thus, during these months, there is in the atmosphere the aqueous vapour, and these being relatively dry months, there are also the conditions of ascending currents. There is, however, wanting another element essential to the electrical manifestations of the thunderstorms during the relatively dry season of Mauritius. Now during the months when thunderstorms are of no infrequent occurrence, the high atmospheric pressure of Asia repeatedly advances, as Dr. Meldrum has pointed out, southward towards Mauritius, so that frequently the belt of variable winds and calms, between the two trades, stretches in a slanting direction from Madagascar to Ceylon. While this distribution of pressure occurs with more or less frequency, the conditions of a descending cold current of large volume are provided, and thunderstorms are frequent; and it is under analogous conditions afforded by the cyclones and anticyclones of north-western Europe, that nearly all the winter thunderstorms in the west of Scotland occur. But from June to September there is an unbroken increase of pressure from Central Asia southwards to beyond Mauritius, thus placing it within this high pressure area and in the heart of the south-east trades, and while this continues the conditions favourable for the development of the thunderstorms are wanting.

It has been shown that over the open sea thunderstorms are essentially nocturnal phenomena. As regards thunderstorms over the land surfaces of the globe, the disturbance of atmospheric equilibrium, resulting in ascending and descending currents,

is brought about mainly by the super-heating of the surface and thence of the lowermost strata of the air. But as regards the open sea, this mode of disturbing the atmospheric equilibrium cannot take place, inasmuch as the influence of solar radiation is only to raise the temperature of the surface of the sea not more than a degree. Hence it is probable that the disturbance of the equilibrium of the atmosphere in the case of thunderstorms over the open sea, is brought about by the cooling of the higher strata of the atmosphere by terrestrial radiation.

An inspection of the curves of thunderstorms for Oxford, or of thunder with lightning, and of lightning without thunder (Pl. II. figs. 26 and 27), shows that they are quite different from each other,—the difference, and it is a vital one, being that while the curve for thunderstorms is coincident with the afternoon minimum, the curve for lightning only is coincident with the evening maximum of atmospheric pressure, or from five to six hours later. Part of this, but no more than an insignificant part, is due to those instances of heat-lightning which are but the reflection of distant flashes of lightning, the thunder accompanying which is not heard. By far the majority of the cases of heat-lightning are not connected with thunder, as is conclusively shown by the curve for August at Oxford, where the very pronounced maximum occurs during the two hours from 9 to 11 P.M., long after darkness has set in, and when the curve for thunderstorms has fallen from the daily maximum to near the minimum. I have calculated or otherwise collected the averages for the curves of these phenomena for nearly two hundred places in all climates of the world, and the result is to show that the two curves are essentially distinct and different from each other, showing conclusively that many electric discharges are not accompanied with thunder.

As explained, the diurnal maximum of heat lightning is coincident with the evening maximum of atmospheric pressure, that is, during those hours when the upper strata over the place are having poured over them a warmer and moister stratum of air which has its origin in the ascending current of the longitudes immediately to westward, where the afternoon minimum of pressure is then taking place. In this connection it is highly significant that while in May the number of cases of lightning was 17, in August, when the ascending current has much greater relative and absolute humidity, the number of cases was 82, or about five times greater than in May.

Over the open sea, the diurnal curve of lightning is closely coincident with the evening maximum of pressure, the maximum occurring about midnight (see Table, p. 31). The relations of the maximum of lightning to thunderstorms over the open sea is essentially different from what obtains over land. Thus, while over land the maximum of lightning occurs from five to six hours later than that of thunderstorms, over the ocean it occurs about four hours earlier. The order of occurrence of these phenomena in the summer months is this—thunderstorms over land, from 2 to 6 P.M.; lightning

over land, 8 P.M. to midnight; lightning over the open sea, 8 P.M. to 4 A.M.; and thunderstorms over the open sea, 10 P.M. to 8 A.M.

The evening maximum atmospheric pressure occurs at the time when the aurora attains its diurnal maximum. Thirty years' observations at Christiania Observatory give the number of times the aurora was observed each hour as under :—

Hour ending 4 P.M.	7 times.	Hour ending 1 A.M.	53 times.
„ 5 „	16 „	„ 2 „	42 „
„ 6 „	46 „	„ 3 „	21 „
„ 7 „	105 „	„ 4 „	10 „
„ 8 „	133 „	„ 5 „	11 „
„ 9 „	156 „	„ 6 „	1 „
„ 10 „	529 „	„ 7 „	0 „
„ 11 „	130 „	„ 8 „	1 „
„ Midnight	79 „	Total,	1320 times.

Of the 1320 instances recorded, it is seen that 529 occurred in the hour from 9 to 10 P.M., and in the four hours from 7 to 11 P.M. 948 cases were observed, a result probably dependent in no small degree on the atmospheric conditions resulting in the evening maximum of pressure, the more abundant ice spicules in the upper regions at the time serving as a screen for the better presentation of any magneto-electric discharges that may occur.

Monthly, Annual, and Recurring Phenomena.

Of the annual recurring phenomena of the atmosphere, the distribution of atmospheric pressure, atmospheric temperature, and the prevailing winds of the globe, during the months of the year have, as the more important, been thoroughly revised for this article. The data on which the revision is based are given in Tables V. to IX., and the results are graphically represented on Maps I. to LII., which show the monthly isothermals, isobars, and prevailing winds over the globe. These represent the average temperature, pressure, and direction of wind over the larger portion of the land surfaces of the globe based on the fifteen years' observations beginning with 1870 and ending with 1884.

Charts showing by *isobaric lines* the mean pressure of the atmosphere through the months of the year, may be considered as furnishing the key to the fundamental questions of meteorology, since it is only by the information thereby obtained that questions relating to the prevailing winds, and the varying temperature, cloud, and rainfall of different regions, can be satisfactorily handled.

Now, in an inquiry into the comparative mean distribution of atmospheric pressure, it is clear that the first, and indeed, as respects time, the essential requisite, is that the means be drawn from observations made in the same years. In tropical and most sub-tropical regions, where the mean pressure differs but little for the same month from year to year, that the observations be for the same years is not a matter of such paramount importance; but elsewhere, owing to the more or less marked instability which prevails with regard to pressure, it becomes of the utmost importance to obtain the means of observations for the same years.

Mean Pressure.—The mode in which the observations were discussed was first to extract, for each country by itself, the mean monthly pressures reduced to 32°, where these were obtainable, year by year. Since in this way the curve of variation from month to month was easily kept in mind, many typographical errors, faulty averages calculated from portions of months only, and other anomalies, were detected, and these doubtful means were at once inquired into and rectified.

As the work advanced, the mean annual pressure, further reduced to sea level, for each station for which observations for the whole of the fifteen years were available, was entered on maps of the countries. The results for every country showed anomalies and discordances in the barometric means, which called for inquiry with a view to their rectification approximately.

No inconsiderable number of errors were occasioned by incorrect heights. These have been rectified by correspondence; but in cases where no levelling or trigonometrical survey has been made, approximate heights have been adopted, deduced from the annual chart of mean pressure. Some errors were found to be due to the state of the barometer, or to its verticality. But the larger number of anomalies had their origin in the personal errors of the observers, arising mainly from the different methods employed in setting the vernier of their barometers. These may be classed as under: (1) setting the vernier in the line of that part of the top of the mercury which is in immediate contact with the glass tube, the instrument being thus read about 0·033 inch too low, more or less, according to the diameter of the tube; (2) setting the vernier by bringing it down till the speck of light on each side is on the point of disappearing, the error in this case being from 0·008 inch to 0·020 inch too low, according to the breadth of the slit; (3) setting the vernier so that a clear space is left between it and the tangent to the mercurial curve, the error in this case being about 0·010 inch too high. The last method of reading is mostly caused by weak or failing sight, the observer not being aware that a lens or spectacles is now required, and consequently it does not materially affect the observations, when two readings are made, as from a Fortin or siphon barometer. It leads, however, to the above error of about 0·010 inch with Board of Trade and other barometers, which take no account of the height of the mercury

in the lower limb of the instrument. This inquiry leaves little if any doubt that these personal errors, in one form or other, are more general than might have been supposed, and accordingly, particular attention was given, in extracting the monthly means, to all changes made as regards observers, with a view to ascertain their personal errors.

There was no real difficulty in ascertaining the errors of particular barometers in countries where stations are more or less numerous, and the meteorological system under a competent control, if the ordinary sources of error are kept in view. But over large portions of South America, Africa, and Oceania another method for the detection of errors was required. In these regions the barometers have been controlled by Baillie's Isobars for the ocean, recently published by the Meteorological Council. In this work the annual chart is the mean of the four months, February, May, August, and November. The mean pressure at 32° and sea level, for the four months, was calculated for the stations of these regions, and the result being entered in its place on the annual chart, the approximate error of the particular place was ascertained. It may be added that Baillie's Isobars may well serve as a control, seeing they are exclusively drawn from observations made only with properly compared barometers. In Table V., the corrections which have been adopted are in every case entered in the last column, from which, it need scarcely be added, the original uncorrected observations may, if desired, be found.

In the first place, the figures entered on the maps were restricted to those stations from which observations for each of the fifteen years were available. It may be said of no country that the number and distribution of its stations, furnishing observations for the whole of this period, are sufficient for the purpose on hand. Hence it was absolutely necessary in an inquiry where the same time must be dealt with, to cover the ground in a more adequate manner with the means of other stations at which observations have been made for other periods than the fifteen years, these means being deduced by applying corrections to the monthly means arrived at by differentiation with neighbouring stations.

In differentiating, the work was overtaken generally according to the length of the times covered by the period of the observations of the stations, the means of which were in the course of being rectified, beginning with the longest periods and ending with the shortest. In a good many cases the same period for differentiation was made to embrace a very wide area. Thus, over considerable portions of France, Germany, Italy, and North Africa, observations were available only for the seven years 1878 to 1884. The following table was accordingly prepared, showing for forty-three places the differences in thousandths of an inch of each month's average for these seven years, compared with the averages of the same months for the fifteen years, which may serve as an example of the method of differentiating employed :—

TABLE.—Showing, for Forty-three Places in Western and Southern Europe, the differences between the Monthly Barometric Means of the seven years 1878–84 and the fifteen years 1870–84. The minus sign indicates that the correction to be applied to the means of 1878–84, to bring them to the means of 1870–84, is subtractive, and no sign that it is additive.

N.B.—The differences or corrections are expressed in thousands of an inch.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Falmouth, . .	-111	8	-33	60	10	25	20	30	5	-50	-69	-34	...
Jersey, . .	-98	-4	-33	56	-1	24	14	16	3	-45	-70	-27	...
Brighton, . .	-97	-4	-31	45	8	24	25	44	7	-38	-51	-15	...
Flushing, . .	-86	-5	-36	55	0	34	25	24	5	-22	-38	-10	...
Utrecht, . .	-60	-14	-32	36	0	30	26	28	2	-24	-40	-8	...
Cologne, . .	-52	-8	-26	40	0	30	18	22	8	0	-50	-16	...
Göttingen, . .	-20	6	-32	38	-10	24	28	22	4	-10	-44	4	...
Bayreuth, . .	-36	-16	-20	40	-4	26	24	30	20	5	-34	4	...
Munich, . .	-40	-20	-24	44	-4	20	20	24	24	-6	-64	-20	...
Carlsruhe, . .	-54	-22	-23	46	3	24	16	26	8	-6	-44	-20	...
Luxemburg, .	-52	-32	-30	40	4	20	20	32	8	-20	-56	-24	...
Paris, . . .	-72	-16	-24	56	0	24	12	24	20	-24	-60	-28	...
Ste. Honorine-du-Fay, . .	-76	-16	-16	48	-4	22	10	20	4	-40	-58	-32	...
Lyons, . .	-52	-28	-24	52	-12	12	12	12	20	-18	-70	-38	...
Montpellier, .	-32	-28	-10	62	0	24	16	12	12	-16	-48	-32	...
Perpignan, . .	-48	-32	-26	24	-12	4	8	16	12	-12	-70	-48	...
St. Martin de Hinx, . .	-34	-6	-5	61	4	16	6	22	4	-6	-58	-40	...
Coimbra, . .	-24	-24	-6	34	-12	-4	2	6	-12	-6	-46	-50	...
Lisbon, . .	-16	-24	-8	32	-12	-8	4	4	-18	-8	-44	-48	...
Madrid, . .	-28	-18	-20	40	-12	8	2	8	-12	-10	-34	-48	...
San Fernando, .	-16	-24	-12	16	-12	-6	4	6	-12	-10	-32	-38	...
Gibraltar, . .	-14	-28	-6	17	6	5	4	10	0	-13	-36	-38	...
Alicante, . .	-32	-36	-24	40	-12	4	8	10	0	-30	-60	-32	...
Palma, . .	-32	-24	-24	36	0	6	8	6	5	-28	-66	-40	...
Athens, . .	-12	-20	-20	20	2	8	10	6	12	-8	-48	-14	...
Malta, . .	-10	-48	-32	20	-14	-10	4	7	24	-16	-70	-30	...
Palermo, . .	-20	-40	-18	32	-4	8	4	4	24	-18	-76	-38	...
Naples, . .	-18	-40	-30	36	-8	10	6	14	26	-12	-56	-28	...
Rome, . .	-16	-25	-22	40	0	13	11	16	26	-10	-56	-26	...
Lesina, . .	-28	-50	-36	28	-12	8	0	12	20	-12	-70	-44	...
Trieste, . .	-36	-52	-30	32	-10	10	8	6	14	-10	-80	-36	...
Venice, . .	-36	-44	-32	28	-20	4	0	6	14	-20	-82	-56	...
Perugia, . .	-28	-44	-30	32	-14	4	0	8	20	-16	-64	-40	...
Modena, . .	-32	-36	-24	28	-12	10	4	12	20	-6	-66	-40	...
Milan, . .	-36	-36	-24	36	-18	10	10	16	20	-4	-64	-44	...
Mondovi, . .	-32	-36	-24	32	-10	12	16	16	24	-6	-52	-40	...
Turin, . .	-36	-40	-24	36	-12	12	16	20	24	-28	-66	-40	...
Genoa, . .	-20	-36	-14	40	-6	12	16	18	24	-12	-70	-40	...
Geneva, . .	-44	-26	-24	14	-8	18	8	16	20	-12	-72	-50	...
Basel, . .	-48	-28	-28	46	-8	12	8	10	16	-12	-52	-18	...
Zurich, . .	-48	-34	-32	36	-10	8	2	12	14	-16	-56	-40	...
Berne, . .	-36	-24	-30	44	-6	14	8	14	20	-8	-56	-28	...
Leipzig, . .	-44	-16	-22	32	-8	24	26	28	6	4	-32	-2	...

These differences were then entered on small maps of Europe, from which, by the corrections thus found, the monthly means of the stations were brought to the means of the fifteen years. In certain districts, where necessary, differences were found for additional stations to these forty-three. Hence for all stations in the table for which the period of observation is entered as fifteen years, 1870–84, the means are simply the arithmetical averages of observations made during that period, or they are the approximate means for the same years. An examination of the above table, or better still, of a map on which the figures are entered, will show that the limit of error of any deduced approximate mean is in each case small.

In the United States, the term of years employed is not the fifteen years ending with 1884, but the thirteen and one-fourth years extending from October 1871, when the Signal Service of the War Department took charge of the Meteorological System of the States, to December 1884. A comparison of the averages of these thirteen and one-fourth years, with those of the fifteen years for about a dozen stations from which observations have been obtained for the whole fifteen years, shows that the two sets of averages closely agree. The isobars are therefore drawn from data virtually synchronous for the greater portion of the land surfaces of the Northern Hemisphere.

But generally over the Arctic Regions, South America, Africa, and Polynesia no such full information is available; the means of the observations actually made are alone printed, except in such regions as Southern Africa, Australia, and Japan, where the number and proximity of the stations seemed to warrant differentiation.

Correction for Range.—The means in Table VI. are, in each case, for the hours specified, no correction being applied here for variation due to diurnal range. But in preparing the figures for the drawing of the isobars, corrections were applied with the view of bringing the means for the hours observed to the daily means. In this part of the work the corrections in each case were taken from the copious Tables III. and IV. of hourly barometric range given in the Appendix, pp. 7 to 48. Care was taken in correcting for range to use only data furnished by a station or stations similarly situated geographically to the station the means of which were to be corrected. Thus Mullaghmore and Belmullet were corrected from Valentia, Parsonstown from Armagh, Holyhead from Liverpool, Cambridge from Oxford, Edinburgh from Makerston and Aberdeen, and other places in a like manner. Here the results of the Challenger observations, given in Table III., were of great service in correcting the means for small islands and coast stations over large regions of the globe. It need scarcely be added that the hourly variations for such stations as Gries and Klagenfurt in Austria, and Cordova in the Argentine Republic, situated in deep narrow valleys, were in no case employed, for the reasons already stated. Further, the means at places situated on plateaux more or less elevated, were not corrected from the hourly variations of such high level stations as Ben Nevis, Säntis, and Hoch Obir, which, being placed on true peaks, have

a totally different diurnal barometric curve from that of a place situated on a plateau, though its height and geographical position be otherwise similar.

Correction for Height.—Table V. gives the corrections for height which have been employed in reducing to sea level the barometric means of Table VI. This table is based on the formula given by Laplace in his Mécanique Celeste, which is published in Mr. Scott's Instructions in the Use of Meteorological Instruments, p. 80; modified by the results obtained from four years' observations at the Ben Nevis Observatory, 4406 feet high, as determined by levelling, and those at its low level station, near the sea at Fort William.

The four years' observations ending with 1887, give a decrease of temperature with height, at the rate of one degree Fahrenheit for every 270 feet of ascent. This rate has been adopted in arriving at the approximate mean temperature of the intervening stratum of air between the stations, the barometric means of which are being reduced to sea level. Since, in this discussion, the monthly means based on series of years' observation are alone dealt with, these approximate means may be regarded as sufficiently close to the true means for the purpose on hand. The mean of the intervening stratum of air being assumed to be the arithmetical mean of the temperature at the station and that of the sea level to which the reduction is made, the temperature of the intervening stratum was, in practice, found by adding to the station temperature a correction, at the rate of one degree Fahrenheit for every 540 feet in height.

The Ben Nevis Observatory and the Fort William stations are perhaps the best pair of stations yet established from which the requisite data can be obtained in connection with the inquiry as to the rate of the diminution of pressure with height; these two stations affording the conditions of great difference in height, combined with close proximity, and the positions of the thermometers in situations where the effects of solar and terrestrial radiation are minimised.

The corrections for height, for the Ben Nevis Observatory, for different sea level pressures and different air temperatures were empirically calculated from the observations. In applying the first results thus calculated, it became evident that it would be necessary to employ only those observations which were made when the wind blew at lower rates than thirty miles an hour, the reason being that the winds of higher velocities, as they brush past the buildings of the Observatory, suck the air out from the room where the barometer is hung, thus lowering the pressure; and the higher the velocity, the greater is the effect on the pressure thus produced.

A table of corrections for a height of 4406 feet was prepared in this way for sea level pressures, varying from 27·500 inches to 30·800 inches, and for air temperatures varying from 15° to 66°. For these same temperatures and sea level pressures, a similar table of corrections for Ben Nevis Observatory was constructed from Laplace's formula.

On comparing this latter table with the empirical one, it was seen that the two agreed throughout in giving the same differences between two different sea level pressures at the same air temperatures. But the two tables differed essentially when compared as to their differences for the same sea level pressures at different air temperatures. At the air temperature of 45° the two tables agreed, at lower temperatures the corrections from Laplace's formula were too large, and at temperatures higher than 45° too small. It was found that, when the additions to the corrections in the Laplace table for air temperatures lower than 45° were reduced by one-sixth, and the subtractions from the corrections as the temperature rose above 45 were also reduced by one-sixth, the two tables were virtually identical. It may be noted here that the differences among the corrections for height arising from the varying air temperatures thus deduced from the Ben Nevis Observations substantially agree with the differences in Hazen's Table for the reduction of Air Pressure.[1]

A table was then constructed from Laplace's formula for a sea level pressure of 30·000 inches for latitude 45°, and for air temperatures from −20° to 90°, and for heights up to 8000 feet. To the figures of this table were applied corrections for the different air temperatures, in accordance with the results of the Ben Nevis Observations. The result is given in Table V., which has been used in reducing the barometric means of Table VI. to sea level. The table is, however, only regarded as a provisional one, giving tolerably good approximations to the true corrections for height.

But the really serious difficulties encountered in reducing barometric observations to sea level are presented by the air temperatures, and unless these difficulties are kept steadily in view, no little confusion will be the result in representing the course of the isobars. The more serious of these difficulties are experienced in dealing with stations situated in deep, narrow valleys, and stations on elevated plateaux.

This is well shown by the observations made at Obirgipfel in the Tyrol, which is a high level station on a peak 6706 feet high, and at Klagenfurt, about 7 miles distant, in a deep valley adjoining, at a height of 1437 feet, there being thus a difference of 5269 feet in height between them. Now the differences of temperature between the monthly means of these two situations for the five years 1880 to 1884 are these, the figures showing the excess of the temperature of Klagenfurt above that of Obirgipfel:—

0·7, 5·8, 12·6; 19·4, 22·0, 21·2; 18·5, 17·6, 16·4; 13·9, 7·7, 6·1,

and for the year 13·4. Now, since the station at Obirgipfel is situated on a true peak, it follows that the temperature there recorded will closely approximate to the temperature of the free atmosphere at that height. But at Klagenfurt it is far otherwise, for being situated in a deep narrow valley, the night and winter temperatures, as already explained, are greatly too low, and the day and summer temperatures are too high. The mean winter temperature at Klagenfurt is only 4°·2 lower than that of the

[1] Washington, 1882.

neighbouring station 5269 feet higher, and in January it is only 0°·7 lower. Hence, if in these months the temperature of Klagenfurt be used in calculating the temperature of the intervening stratum of air from that place to sea level, it would be much too low, and in all probability the sea level pressure for Klagenfurt would be made nearly 0·030 inch above what it ought to be. But even if it be supposed that the temperature of the intervening air stratum could be tolerably approximated to, the barometric observations themselves made in such situations are so strictly local, being largely increased during the cold hours of the day and seasons of the year and diminished during the warm times of the day and of the year, that they would only mislead if used in drawing the isobaric lines of the region where they are situated. Hence in this work the barometric means of such stations as Gries and Klagenfurt in Austria, and Cordova in the Argentine Republic, though printed in the table, have not been used in drawing the isobaric lines; and all care was accordingly given to keep the maps, from which the isobarics were drawn, clear of sea level pressures deduced from observations made in such situations. It is probable that this consideration explains what look like anomalous observations at a number of places, about the local situation of which there is no information.

Gravity Correction.—The barometric means in Table VI. have not been corrected for gravity. But as the sea level pressures entered on the maps were reduced to gravity at lat. 45°, the isobars on the maps are corrected for gravity. The following are the corrections for gravity at a pressure of 30·000 inches which have been used:—

Lat. N. or S.	Cor.	Lat. N. or S.	Cor.	Lat. N. or S.	Cor.	Lat. N. or S.	Cor.
°	inch.	°	inch.	°	inch.	°	inch.
0	−·080	25	−·052	50	+·014	75	+·070
1	·080	26	·049	51	·017	76	·071
2	·080	27	·047	52	·019	77	·072
3	·080	28	·045	53	·022	78	·073
4	·079	29	·042	54	·025	79	·074
5	·079	30	0·40	55	·027	80	·075
6	·078	31	·038	56	·036	81	·076
7	·078	32	·035	57	·033	82	·077
8	·077	33	·033	58	·035	83	·078
9	·076	34	·030	59	·038	84	·078
10	·075	35	·027	60	·040	85	·079
11	·074	36	·025	61	·042	86	·079
12	·073	37	·022	62	·045	87	·080
13	·072	38	·019	63	·047	88	·080
14	·071	39	·017	64	·049	89	·080
15	·070	40	·014	65	·052	90	·080
16	·068	41	·011	66	·054	...	...
17	·066	42	·008	67	·056	...	...
18	·065	43	·006	68	·058	...	...
19	·063	44	−·003	69	·060	...	...
20	·061	45	·000	70	·061	...	...
21	·060	46	+·003	71	·063	...	...
22	·058	47	·006	72	·065	...	...
23	·056	48	·008	73	·066	...	...
24	·054	49	·011	74	·068	...	...

Correction for Mean Temperature.—The period selected for the mean temperature observations is the fifteen years adopted for pressure, beginning with 1870 and ending with 1884. From the remarkable extension of meteorological observation in recent years, data of greater fulness and of higher quality are now available for drawing isothermals over the globe, which therefore represent the geographical distribution of temperature with a degree of approximation to the truth not previously attainable.

The methods of discussing the observations are, to a large extent, the same as those detailed and explained in dealing with the observations of atmospheric pressure, with, however, several important differences.

Since the observations made use of preferentially in this inquiry are the daily maximum and minimum temperatures, special attention was given in making the extracts of the monthly means to detect, where possible, any cases that may have occurred of the minimum thermometer having got out of order, as not unfrequently happens, and allowed, from inadvertence, to remain out of order for some time. These errors, together with typographical errors and many of the errors of computation, were the more readily detected by the practice adopted of extracting the means of the separate years in succession for each country or region by itself, so that the curve of monthly variation of each year being easily kept in mind, any deviation from it was seen with little difficulty.

When observations are read to the tenth of a degree, the personal errors of observation may be neglected. But when the readings are only to whole degrees, two kinds of errors are certain to occur where provision is not made to secure that each observer is properly taught. These two sorts of error are, (1) taking the degree which the mercury or spirit has just passed ; or (2) taking the degree immediately above the top of the mercury or spirit. In the former case, the means deduced from the observations will be half a degree too low, and, in the latter case, half a degree too high. In many cases these faulty methods of observing may be detected from the annual means, corrected for height, entered in maps of the country whose temperature is being discussed.

By the same method the errors of faulty thermometers may be detected. In all cases where for this assumed cause the means have been corrected to the extent of 1° or upwards, the amount of the correction is stated in the last column of the table under "Corrections applied." In such cases as Portland in Victoria, Australia, where the published mean temperatures were for many years about 5° too high, but where the error was rectified some time ago, the correction was applied to the observation of the years in error, but no note is made of it in the last column of the table.

Again, in cases where "mean temperatures" alone are published, and no information given whence these have been derived, a change of hours sometimes takes place

of which no notification is given, and apparently no allowance is made for the change. Thus at Hobart Town for some years, the hours of observation appear to have been 9 A.M. and 1 and 5 P.M., and the mean of the observations at these hours was adopted as the mean temperature, with the result of winters apparently 2° and summers 6° warmer than before. The figures for Hobart Town in the table have been brought to mean temperatures by correcting each year's observations by the table of corrections for hourly range at this place. It may be mentioned that these faulty mean temperatures at Portland and Hobart Town for long thrust the isothermals of this part of the globe seriously out of their proper positions.

In a large number of instances the monthly means in the table are the means of particular hours of observation uncorrected in any way, such as 6 A.M., 2 P.M., and 10 P.M.; 7 A.M., 1 P.M., and 9 P.M.; 4 A.M., 10 A.M., 4 P.M., and 10 P.M.; 8 A.M. and 8 P.M.; 9 A.M. and 9 P.M. The means were corrected for daily range where such corrections were required, and after being corrected for height, the resulting means were entered in their places on the map.

In correcting for height, the correction adopted is at the rate of 1° Fahr. for every 270 feet in height above mean sea level; and this correction has been uniformly applied to the temperature observations for all seasons and countries. The rate unquestionably varies with season and climate; but as regards the manner and degree of this variation, our information is so scanty, and the worked-out results in many cases are so doubtful, and sometimes even so inconsistent with each other, that it is more in accordance with the present state of our knowledge to adopt provisionally a uniform rate of correction throughout, than a rate varying with season and climate.

Of the causes producing variability in the rate of diminution of temperature with height, the more prominent are season, hygrometric state of the atmosphere, and situation. During the transition from winter to summer, when the great annual rise of temperature is in progress, the rate of diminution of temperature with height is greatest, for the simple reason that at this season the lower layers of the atmosphere are more quickly heated by simple proximity to the earth's surface, thus increasing the difference between the temperatures at low and high levels. On the other hand, in autumn, when the great annual fall of temperature occurs, the lower strata of the atmosphere are more cooled by the now rapidly cooling surface of the earth, and accordingly the difference between the temperatures of the low and high levels is proportionally lessened.

Observations prove that the more aqueous vapour there is in the atmosphere in the form of cloud, and to a large degree even in a purely gaseous form, the more is the earth's surface protected from the effects of solar and terrestrial radiation. It follows therefore that in rainy climates, and during the rainy season in the tropics, the rate of diminution of temperature with height is comparatively a stable quantity hour by

hour, day by day, and season by season, at least as compared with what obtains in dry climates and seasons. In truth, as regards dry climates the diurnal variations in the fall of temperature with height, particularly in the warm months of the year, are so varying and uncertain, that it will probably for ever remain a hopeless problem to reduce a barometric observation made at any particular hour to sea level at places, say 1500 feet in height and upwards, with a tolerable approximation to the truth. The reason is, that it is not then possible to deduce from the observations made the approximate mean temperature of the stratum of air between the station and sea level. In constructing daily weather charts, the difficulty is in some degree met by combining with the temperature at the time of observation, the temperature at one or two previous observations. In this work all these difficulties are very greatly reduced, since what are dealt with are only the mean pressures and temperatures of series of years. In drawing the isobars and isothermals, greater weight has been given to the observations made at low than at high stations.

As respects situation, the least variation in the rate of diminution of temperature with height occurs at places near the sea, and particularly on the windward coasts of land areas, and the rate varies from the normal on advancing into inland climates. At high level stations situated on true peaks, the rate closely approximates to the normal; but on elevated plateaux the deviation is considerable, and increases with the dryness of the climate and the intensity of solar and terrestrial radiation.

Now as regards this discussion, observations from such stations as the above may be considered as affording sea level pressures and temperatures sufficiently close to the truth as to warrant the using of them as part of the data from which the isobars and isothermals of the globe may be drawn.

But it is quite otherwise when we come to deal with observations made at stations situated in deep valleys, such as Gries, Klagenfurt, and Cordova, at which temperature is abnormally lowered when terrestrial radiation is in excess, and abnormally raised when solar radiation is strong. For this reason, not only have those stations been wholly left out in drawing the isobars and isothermals, but also all others known to be in situations more or less similar. Since information is often not supplied regarding the physical configuration of the earth's surface where the station is situated, it was found necessary to resort to an examination of the diurnal range of the barometer, as shown at the observed hours of the station, in order to arrive at some knowledge as to whether the station was situated in the open or in a deep valley. In this way stations were marked as supplying data either altogether unsuitable, or only partially suitable in this discussion.

It is scarcely necessary to add that observations made at stations in deep valleys, not only mislead in drawing the isobars and isothermals of a country, but they are absolutely useless, and even worse, when used as data contributing to the solution of

the problem of the rate of diminution of temperature with height. This consideration has unfortunately been often lost sight of, particularly in framing tables of corrections for height intended for different climates and seasons.

In differentiating for stations at which observations were not made for the whole of the fifteen years ending with 1884, in order to bring their means to the means of these years, the same methods were adopted as those used in preparing the monthly means of atmospheric pressure. Very special care was taken to differentiate coast stations only with coast stations, and inland stations with inland stations. Also when, in differentiating, the observations of only a few years were available, the geographical distributions of abnormally high or abnormally low monthly temperatures during these years were carefully noted in their bearings on the monthly means being worked out.

Wind.—The observations of wind are given in Tables VII. and VIII. In all cases where possible, the mean direction of the wind has been worked out in the form given in Table VII. Climatologically, the most satisfactory way of presenting this most important element of climate is by giving the mean number of days each month which each wind, N., N.E., E., etc., prevails. If only the mean direction is given, as is done in Table VIII., the variability of this important factor of climate from the prevailing direction is absolutely neglected, and the climatic value of the record seriously lowered.

In this discussion no account has been taken of the force or velocity of the wind, such observations being still too meagre and too crude for any satisfactory use being made of them.

It has not been possible, owing to the want of the observations, to give for many regions the same weight as regards time to the means of the winds, as to the means of pressure and temperature. This has, however, been done as respects the United States, the North Atlantic, and a large portion of the Europeo-Asiatic continent, where these three elements of climate are substantially synchronous, and where, therefore, their relations can be more closely compared. So far, however, as affects the mean direction of the wind, it soon appeared in the course of the discussion that a shorter term of years is required to give a close approximation to the true means, than in the case of the pressure or the temperature. Hence an attempt has been made, in those regions where the observations are not obtainable for the whole period of the fifteen years, to collect the averages for as long terms of years as possible. The hours of observation from which the means have been calculated, when known, are stated; and where a selection of hours could be made, those hours were chosen which appear to give the best daily mean in view of sea and land breezes. Wherever it could be attempted, means deduced from hourly observations have been given, which alone really inform us as to the mean daily direction of the wind.

In preparing the tables of pressure, temperature, and wind, the aim has been to make the selection of stations represent fairly well the more important climatological features of the region under discussion. There are, however, large regions where the data are given with a greater fulness than this, such as the British Islands, Denmark, Holland, Spain, Italy, Cyprus, India, the United States, and the Argentine Republic. This is done for the purpose of showing more in detail, than the charts can show from their size, the influence of land and water, mountains and plains, on the climatic problem. As regards Denmark, the means, particularly of the wind, have been more fully worked out, owing to the position of this country between the mountains of Scandinavia and the mountains to the south of it, and the important resulting consequences of that position on the tracks of the cyclones and anticyclones of Europe.

Another object aimed at in the fuller discussion given to certain countries, was a search for guiding information as to the influence of land and water, plain and mountain on these lines, in order that the most probable course might be assigned to the isobars and isothermals in those parts of the globe where observations are too few and far between to serve of themselves for the drawing of these lines.

In drawing the isothermals and isobars and entering the arrows showing the prevailing winds on the maps, much of the information contained in the following works has been utilised, in addition to what is given in the Tables :—

Contributions to our knowledge of the Meteorology of Cape Horn and the West Coast of South America, by Richard Strachan. Contributions to our knowledge of the Meteorology of the Antarctic Regions, by Richard Strachan. Charts of Meteorological Data for Square 3 Lat. 0° to 10° N., Long. 20° to 30° W. Charts of Meteorological Data for the nine 10° Squares of the Atlantic which lie between 20° N. and 10° S., and extend from 10° to 40° W. Contributions to our knowledge of the Meteorology of Japan, by Captain Tizard, H.M.S. Challenger. Contributions to our knowledge of the Meteorology of the Arctic Regions, by Richard Strachan. Charts of Meteorological Data for the ocean district adjacent to the Cape of Good Hope. Charts showing the Mean Barometrical Pressure over the Atlantic, Indian, and Pacific Oceans, by Lieutenant Baillie, R.N. *Published under the authority of the Meteorological Council.*

Weather Charts of the Bay of Bengal and adjacent sea north of the Equator. Weather Charts of the Arabian Sea and the adjacent portion of the North Indian Ocean. *Published by the Meteorological Department of the Government of India.*

Various publications on Ocean Meteorology and on Ocean Routes, issued by the Meteorological Institutes of Holland, Germany, France, and Norway.

The Winds of the Globe, by Professor Coffin and Dr. Alexander Woeikof. *Published by the Smithsonian Institution.* As regards this large work, it is only the more important data referring to the oceans which has been utilised.

And also for the Winds, the Meteorological Charts of the North Pacific Ocean from the Equator to Lat. 45° N., and from the American Coast to Long. 180°. By Commodore Wyman, U.S. Navy, Washington, 1878.

It is right to acknowledge here the invaluable assistance received from the meteorological writings of Dr. Hann, who holds the first place among meteorologists for the importance, extent, and trustworthiness of his contributions to the climatologies of the globe.

In the preparation of the Tables I have been assisted by Mr. H. N. Dickson and Miss J. H. Buchan of the Scottish Meteorological Society's office. Miss Buchan has assisted during the whole time of the discussion. She copied out the whole of the Challenger observations, chronologically arranging them according to subject, and assisted in working out the hourly and other averages; she also collected and computed a large part of the new wind averages given in Table VII., a considerable proportion of which were laboriously calculated from daily observations, and several even taken from daily curves of wind direction; and she aided generally in checking the correctness of the computed averages. I had the benefit of Mr. Dickson's help during 1887 and 1888. He computed the air temperatures of the North Atlantic from the Bulletin of International Meteorology; further assisted in the preparation of Table V.; carried out the work of differentiation for the mean temperatures at a considerable number of places in the Russian Empire; charted the greater part of the temperatures; and prepared the first draught of the isothermals for large portions of the globe.

THE TEMPERATURE, PRESSURE, AND PREVAILING WINDS OF THE GLOBE.

These prime elements of climate will, from their intimate relations to each other, be more satisfactorily dealt with together than separately. It is scarcely possible to over-estimate the importance of a knowledge of the distribution of atmospheric pressure, or of the mass of the earth's atmosphere over the globe, in its varying amounts from month to month. Observations prove conclusively that winds are simply the movements of the atmosphere that set in from regions where there is a surplus towards regions where there is a deficiency of air; and the nearer the observations of pressure and wind approximate to true averages, the closer is the relation seen to be subsisting between these two distinct phenomena. Again, since prevailing winds to a large extent determine the temperature and rainfall of the regions they traverse, isobaric maps may be considered as furnishing the key to the climatologies of the globe as well as to many of the more important questions of meteorological inquiry. The distribution of temperature in the atmosphere may be regarded as the fundamental problem of meteorology, seeing that the varying pressures, humidities, and winds are either direct or indirect consequences of the varying distribution of temperature. As regards the distribution of the temperature over the land surfaces of the globe, the problem was approximately solved by the

publication of Humboldt's isothermal lines. But as regards the ocean, which comprises three-fourths of the earth's surface, the monthly and annual distribution of temperature in the atmosphere over it can scarcely be said to have been yet seriously looked at.

In these circumstances, the thanks of the climatologist is specially due to the Signal Officer of the United States for the monthly averages for the North Atlantic, which were published for several years in the International Bulletin, and to the Meteorological Council of London for monthly averages for the Red Sea. The required data have thus been available in this work for drawing the isothermals for these important parts of the ocean. A comparison of these means, Table IX., pp. 228–9 and 254–9, and of the Challenger mean air temperatures, Table I., with the temperatures of the sea for the same positions and months, shows that it is absolutely necessary, in the advance of meteorology, that the determination of the monthly temperatures of the air over the ocean be undertaken and carried out. The differences observed between the temperature of the surface of the sea and that of the air over it, so far as a comparison can yet be made in the North Atlantic and Red Sea, point to a much greater prevalence of ascending and descending movements in the atmosphere than is generally supposed. As regards the other oceans, the isothermals of the temperature of the atmosphere must in the meantime continue to be drawn essentially from observations made on the islands and along the coasts of these oceans.

Some interesting results are arrived at by comparing the temperatures of the ocean and air observed by the Challenger. The whole of the observations have been sorted into 174 groups according to geographical position, and the differences entered on a chart of the route of the expedition. In the Southern Ocean, between latitudes 45° and 60°, the temperature of the sea was lower than that of the air. The mean difference was 1°·4, due probably to the temperature of the air being higher owing to the prevailing W.N.W. winds, and that of the sea lower owing to the numerous icebergs. To south of lat. 60° the sea was about 2° warmer than the air, owing perhaps to an increased prevalence of southerly, and hence colder winds in these high latitudes.

The temperature of the sea exceeded that of the air from June 1874 to March 1875, or during that part of the cruise from Sydney to New Zealand, then to the Fijis and through the East India Islands to Hong Kong, and thence to the Admiralty Islands. During the whole of this time, except when near the north of Australia, the sea was much warmer than the air, the excess generally being from 2° to 3°, rising near Tongatabu to upwards of 4°. In passing the north of Australia in September, in which season the wind is off the land and the air therefore dry and sunshine strong, the sea was colder than the air. In the Atlantic, between lat. 20° N. and 20° S., the sea was everywhere warmer, the mean excess being about a degree; and in the Pacific, between lat. 30° N. and 30° S., the sea was also warmer, the excess being a degree and a half.

On the other hand, in the Atlantic from lat. 20° to 40° N., the sea was on the

mean half a degree colder than the air. Similarly in the Pacific, from lat. 30° to 40° N., the temperature of the surface of the sea was half a degree lower than that of the air. The explanation of these differences is probably to be found in the degree of humidity of the atmosphere, the direction of the wind, and the degree in which descending aerial currents mingle with the winds that sweep across the surface of the ocean. It is evident that a wind, issuing from an anticyclone in which descending currents are strong and decided, necessarily possesses quite different hygrometric and temperature qualities from those of a truly horizontal wind which has traversed a large extent of the ocean.

The above remarks refer only to those observations which were made strictly on the open sea. Near land great differences, either way, were observed, which varied with season. At Hong Kong, for example, during the latter half of November 1874, the sea was 3°·7 warmer than the air, the low air temperature being occasioned by the lower temperature of the land and the northerly winds prevailing there at this season. On the other hand, at Valparaiso in November and December 1875, the sea was 5°·8 colder than the air, the low sea temperature being probably occasioned by the upwelling to the surface of the colder water of greater depths by the winds blowing off the land on this coast, similar to what Dr. Murray has proved by extensive observations to prevail in the Scottish lochs.[1]

The distribution of temperature over the globe is shown by Maps I. to XXVI., representing the months and the year. The region of highest temperature, which may be taken as comprised between the north and south isothermals of 80°, forms an irregularly shaped zone, lying in tropical and partly in sub-tropical countries. On each side of this warm zone temperature diminishes towards the poles, and the lines showing successively the gradual lowering of the temperature are, roughly speaking, arranged parallel to the equator, thus showing unmistakeably the predominating influence of the sun as the source of terrestrial heat. While, however, the decrease of temperature corresponds in a general way with what may be conveniently termed the solar climate, there are great deviations brought about by disturbing causes, and among these causes the unequal distribution of land and water holds a prominent place.

January.—During the time of the year when the sun's heat is least felt, and the effects of terrestrial radiation attain the maximum, the greatest cold is over the largest land surfaces which slant most to the sun. Hence the lowest mean temperature that occurs anywhere or at any season on the globe, −61°·2, occurs in January at Werkojansk, lat. 67° 34′ N. and long. 133° 51′ E., in north-eastern Siberia, at a height of 460 feet above the sea. In January 1886, temperature fell at this place to −88°·8, being absolutely the lowest temperature of the air hitherto observed. The lowest mean temperature in America is nearly −40°, and this cold region is situated a little to the north of the magnetic pole.

[1] "On the Effects of Winds on the Distribution of Temperature in the Sea- and Freshwater Lochs of the West of Scotland." *Scottish Geographical Magazine*, July 1888.

In the northern hemisphere the ocean maintains a higher temperature than the land in regions open to its influence, as is seen not only in the higher latitudes to which the isothermals push their way as they cross the Atlantic and Pacific, but in their irregular courses over and near the Mediterranean, Black, Caspian, and Baltic Seas, Hudson's Bay, the American Lakes, and all other large sheets of salt and fresh water. The influence of the ocean and ocean currents in keeping up the temperature during the winter months is most strikingly seen in the North Atlantic, where the isothermal of 35° reaches a much higher latitude in mid-winter than anywhere else on the globe. The conserving influence of sheets of water on the temperature in all seasons is more strikingly shown when the isothermals are drawn for single degrees on maps of a larger scale.

In the southern hemisphere the highest isothermals are 90° in Australia and South Africa, and 85° in South America. It is to be noted that in January, the summer of this hemisphere, the lowest isothermal is 25° in the Antarctic Ocean to the east of South Victoria; whereas in July, the corresponding summer month of the northern hemisphere, the lowest isothermal is only 35°, or 10° higher than in the Antarctic Ocean. The difference is due to the icebergs and icefields of Antarctic regions. In Antarctic and sub-Antarctic regions the change of temperature through the months of the year is comparatively small, the annual range being only about 10°.

In this month the least variation of temperature occurs in the equatorial regions of the Pacific, and in all seasons the variation there is small.

In January the mean pressure of Central Asia rises to about 30·50 inches, which is absolutely the highest mean pressure for any month anywhere over the globe. Now, since the prevailing winds in this anticyclone, which virtually overspreads nearly the whole of Asia and Europe, flow outwards in all directions, bringing S. and S.W. winds over Russia and western Siberia, it follows that the temperature of these inland regions is considerably higher than would otherwise be the case. On the other hand, since the prevailing winds are N.W., N., and N.E. on the east and south of Asia, the temperature of these regions is thus abnormally depressed. Indeed, so strong is this influence of wind direction and ocean combined, that the isothermals run, roughly speaking, north and south in the west of the Europeo-Asiatic continent, and do not assume an east and west direction till about 70° or 80° long. E.

Since in Siberia light airs and calms prevail, and the general drift of the atmosphere is north-north-eastwards towards the higher latitudes of the Arctic regions, the temperature continues rapidly to fall in that direction, with the result that the lowest mean temperature is not coincident with the centre of greatest pressure to the south of Lake Baikal, but occurs at Werkojansk, about thirty degrees of latitude to the N.N.E.

The other anticyclonic regions are North America, in the centre of which pressure rises to 30·20 inches; two in the Pacific to the west of California and of Chile respectively; in the South Atlantic to the west of Cape Colony; and in the Indian Ocean to the west of

Australia. Such regions, and they are well marked, are found in all months and in all oceans about lat. 30° to 40° N. and S., immediately to the westward of the continental masses in these latitudes. The only exception to this is in the North Atlantic in January, and the isobars of this part of the ocean for the months immediately following suggest that this is a true exception. Lieut. Baillie's Isobaric and Current Charts of the Ocean show in an instructive manner that the central spaces of these anticyclonic regions are nearly always avoided by seamen, and therefore practically long known to them. It is scarcely necessary to add that the prevailing winds blow out of them in all directions; and since these winds have the temperature of the upper regions whence they have come increased only by the increasing pressure to which they are subjected as they descend, their temperature often differs considerably from that of the surface of the sea over which they blow.

The lowest isobar, 28·90 inches, is found in the Antarctic regions to the east of New Victoria. The observations of all the months show that there is a permanently low pressure over these regions, lower than is to be found anywhere else on the globe. On all the maps pressure is drawn to the isobar of 29·30 inches, since observations appear to warrant this; but during the summer months of the southern hemisphere lower isobars have been drawn for the portions of Antarctic regions for which observations have been furnished by the various expeditions which have been made into these southern seas.

The most wide-spread low pressure area is in tropical regions, where pressure, except in the eastern half of the Pacific, falls below 29·85 inches. In this extensive region, which covers about two-fifths of the whole surface of the globe, there are three areas where pressure falls still lower. These are the north-west of Australia, Southern Africa, and South America. A line drawn round the globe along the path of least pressure of this zone separates the north and south "trades," indicating the belt or still narrower zone towards which these great aerial currents blow. In the Atlantic and eastern half of the Pacific, where the barometric gradient is well marked, these winds are mapped out with equal distinctness; but in the western part of the Pacific, where the gradient is low and indistinctly marked, the direction of the prevailing winds is irregular and obscure, and it is probable that increased observation will the more strongly illustrate this remark.

It will be observed that the path of least pressure lies north of the equator in the Atlantic and Pacific Oceans. But in the Indian Ocean it is, at this season, south of it, lying in a line from Seychelles to the north of Australia. In this restricted region the winds are especially interesting as illustrating Buys Ballot's Law of the Wind in the Southern Hemisphere.

The next most important low-pressure system overspreads the northern part of the Atlantic and regions adjoining, the lowest mean pressure being 29·50 inches from

Iceland to the south of Greenland. It is this region of low pressure which gives to Western Europe its prevailing south-westerly winds and to North America its north-westerly winds in winter. By these the temperature of Western Europe is abnormally raised by its prevailing winds coming from the ocean and from lower latitudes, and the temperature of North America is abnormally lowered by its prevailing winds coming from Arctic regions and from land in the season when the effects of terrestrial radiation are at the maximum. The opposite action of these winds, which are component parts of the same atmospheric disturbance about Iceland, is shown by the temperature on the coast of Labrador being only $-13°$, whilst in the same latitude, in mid-Atlantic, it is $45°$, or $58°$ higher. This low-pressure region extends eastwards beyond Nova Zembla, and from the resulting winds which follow that extension the rigours of the winter climate of the north of Russia and Siberia as far east at least as Cape Severo are materially counteracted.

The remaining cyclonic centre is in the North Pacific, the lowest isobar being 29·55 inches south of Alaska. The effects of this low pressure on the prevailing winds, and through these on the temperature and rainfall of the north-east of Asia and the north-west of America, is exactly similar to the effects of the low pressure of the Atlantic on the climates of Europe and the United States.

The influence on the pressure of the Spanish and Italian peninsulas on the one hand, and on the other the influence of the Mediterranean, Black, and Caspian Seas is strongly marked; and equally so do the Arabian Sea, India, and the Bay of Bengal leave their mark on the isobars and the winds.

February.—The distribution of temperature in this month is similar to that of January, the chief difference in the northern hemisphere being that in inland situations the influence of the returning sun begins to be distinctly felt in the higher temperatures which now prevail; whereas over the sea and in insular situations, particularly in the higher latitudes, temperatures are even lower than in January, it being in this month that the temperature of the sea falls to, or nearly to, the annual minimum. At Werkojansk the mean temperature has risen from $-61°·2$ to $-51°·9$; and the greater strength of the sun's rays is also well seen in the altered form and positions of the isothermals in the continental regions of North America between lat. 20° and 40°.

The great changes in the distribution of pressure in this month are a considerable diminution over North America south of lat. 50°; in the western part of the North Atlantic, and over the whole of that ocean between lat. 40° and 60°; over Africa, except the south; Europe, except north of a line from the south of Scotland eastward to Wiatka in Russia, and thence northward to the Arctic Ocean; all Asia, except the islands on its east coast, and the north-east of the continent. Elsewhere pressure has risen, notably in the eastern half of the Atlantic, south of lat. 40°, resulting in the formation of an anticyclonic region, which is further developed in the following months; over

Australia, South Africa, and the greater part of South America. Generally speaking, pressure has diminished where temperature has begun most markedly to rise, and the air removed appears to be added to the portions of the atmosphere overspreading the northern half of North America, Europe, Australia, and the region of the Atlantic already referred to. None of the changes, however, are so material as to bring about any serious difference in the prevailing winds as compared with those of January.

March.—In March the lowest isothermal in Asia has now risen to −30°, and in America to −25°, and over all the more strictly continental regions of the northern hemisphere the great annual increase of temperature is rapidly proceeding; but in the more strictly insular and oceanic climates of the globe the change of temperature from that of February is comparatively small, as is well shown by the isothermals of the British Islands, Australia, and New Zealand. The marked increase of temperature on advancing inland, from both the east and west coasts of the United States, and the remarkable flexures of the isothermals of Europe and Asia, in the transition from winter to summer, are very instructive.

The great changes in the distribution of the pressure in this the first of the spring months, are a large diminution overspreading the whole of Asia and Europe, except the British Islands, the North Atlantic to the south of lat. 40°, and North America to the south of lat. 50°. On the other hand, there occurs a very large increase of pressure to northward of these Atlantic and American latitudes, amounting to upwards of a tenth and a half in mid-Atlantic between the British Islands and Labrador; and there is also an increase, though less decided, over nearly the whole of the southern hemisphere, the exception being the South Atlantic, lying between the increasing pressures of Africa and America, which show rather a slight diminution.

In this month the extra-tropical waters of the oceans reach the annual extremes of temperature, those of the North Atlantic falling to the annual minimum, and those of the South Atlantic rising to the annual maximum. Now at this season this region of the North Atlantic, lying between the rapidly-increasing temperature and falling pressure of the Europeo-Asiatic and the American continents, receives an increment of pressure much larger than takes place in any other month of the year.

There are seven anticyclonic areas—in Central Asia, where pressure is rapidly falling from its high winter maximum; in British America, where it is rising to the maximum in spring; two in the Pacific and two in the Atlantic immediately to westward of the continents; and in the Indian Ocean west of Australia. The systems of low pressure are in the north of the Atlantic and Pacific Oceans, in Central Africa and round the South Pole.

April.—This is the first month when the annual increase of temperature is largely felt over both insular and continental regions. The increase is, however, larger in continental climates, and particularly where the rainfall is comparatively small and the

skies clear. Hence, latitude for latitude, temperature is highest in India and in the inland United States to the westward of the Mississippi. The most uniformly distributed temperatures are over the Indian Ocean to the north of lat. 20° S., and in the Pacific between lat. 20° N. and S. On the other hand, the isothermals are much crowded over North America generally, in Senegambia, and South Africa.

As compared with March, pressure has risen over nearly the whole of the southern hemisphere; and in the northern hemisphere, to the north of a line drawn from the mouth of the Mackenzie River to Anticosti, then south-west to near Cape Hatteras, then through the Atlantic eastward to long. 33° W., then northward to lat. 55° N., then eastward to the Ural Mountains, and thence to Cape Severo. Over this latter region the largest increase, being from 0·15 to 0·20 inch, is from West Greenland to the mouth of the Obi. Pressure has now fallen from two to three-tenths in the centre of Asia, whereas in the centre of North America and of Europe the fall only slightly exceeds one-tenth. Over the Arabian Sea and the Bay of Bengal, while pressure has fallen 0·04 to 0·08 inch, it has fallen over India between these two seas from 0·08 to 0·15 inch, or nearly double; and in India the greatest decrease is in the north-west, where the air is driest and temperature is rising most rapidly. The conserving influence of the Mediterranean on the pressure is equally striking. Again, in the North Atlantic, the cold Labrador current, with its low temperature and increased pressure, and the warm southerly current on the east side, with its greatly diminished pressure, suggest interesting connections between changes of pressure and relative surface temperatures.

The high pressure of Central Asia has now all but disappeared, and the high pressure area of the Arctic regions, extending from Lake Superior to Northern Siberia, reaches the annual maximum, the absolute maximum isobar extending from the Arctic Circle in long. 105° W. in a W.N.W. direction to the Liakov Islands. The other anticyclonic regions are Southern Australia, in the Indian Ocean to the south of Madagascar, and the four regions in the Atlantic and Pacific immediately to the west of the old and new continents. It is remarkable that the highest of these, where the mean pressure rises to 30·30 inches, is the one to the west of California, the next highest being the anticyclone in the Indian Ocean, where pressure only reaches 30·15 inches.

Except the Antarctic depression, none of the low pressure areas are strongly marked. The cyclonic regions of the North Pacific and Atlantic are now much reduced in depth and extent; while, on the other hand, that of India has deepened and extended, and new centres of depression have begun to appear in the region of the Rocky Mountains, and in the Pacific to the west of Panama.

May.—As regards temperature, the most noteworthy feature in this the transition month from spring to summer of the northern hemisphere, is the high temperature which prevails in all tropical and sub-tropical regions, particularly where the rainy

season has not yet begun, or where the rainfall is not large. Of this, India, Central Africa north of lat. 10° N., and the more strictly inland regions of North America from about latitude 15° N. in a northerly direction, are the best examples; and in a less degree the more continental portions of the Spanish and Scandinavian peninsulas. The contrast in this respect of India and the Eastern Peninsula is very striking, the relatively low temperature of the latter being probably due to the "lie" of its great valleys in the line of the summer monsoon. The influence of the Red Sea and Persian Gulf in this and subsequent summer months in breaking the continuity of the isothermals and changing their course is very remarkable. The low temperature of the north-eastern portion of America and over the north of Siberia as compared with Western Europe is probably occasioned by the northerly winds which have now set in towards the rapidly developing centres of low pressure in the interior of the continents taken in connection with the sun's position in the heavens.

Accompanying these changes of temperature, pressure has fallen greatly over nearly the whole of the continents of the northern hemisphere, the amount of the fall being generally the same as in the previous month; and again the fall over the Arabian Sea and Persian Gulf is only a half, or even less, than in India, lying between these two seas. A diminution of pressure has also taken place over the south-east of Australia, New Zealand, the southern portion of South America, and over the sea immediately to the south of Cape Colony.

On the other hand, pressure has continued further to increase over nearly the whole of South America and Africa. But the region of the great increase of pressure, or the region to which has been transferred the mass of the earth's atmosphere which has been removed from the Asiatic and American continents, is the Atlantic Ocean from the Arctic Circle south and to at least lat. 20° S., exclusive of the Caribbean Sea, but inclusive of the United States east of the Mississippi and Ohio, Lower Canada, and nearly the half of Europe, to the south of a line drawn from Shetland to the Sea of Azov. The maximum increase, being nearly two-tenths of an inch, occurs in mid-Atlantic, about lat. 45° N. In the Atlantic, from lat. 55° to 70° N., pressure now attains its annual maximum.

A high pressure overspreads nearly the whole of Arctic regions, the maximum, 30·10 inches, extending from the mouth of Back River to Nova Zembla. The other anticyclonic areas of high pressure, in addition to the four in the Pacific and Atlantic Oceans, are found in the centre of South America, in South Africa, to the south of Madagascar, and in Australia. Of these the least pronounced is the one in Australia, and that most pronounced is in the Pacific to the west of California, where pressures are respectively 30·05 and 30·30 inches. Pressure has increased over the anticyclonic region of the North Atlantic; and as pressure all round has considerably fallen, this anticyclone is now a strongly marked one.

The low-pressure system of India has shifted a good way to north-westwards, and deepened to 29·60 inches, and those of Central Africa to 29·70 inches, of North America to 29·80 inches, and of the Pacific, near Panama, to 29·85 inches. On the other hand, the cyclonic systems of the North Pacific have shallowed to 29·75 inches, and that of the North Atlantic to 29·90 inches, and in the adjoining parts of Europe there are five other centres, each of very limited extent, where pressure has fallen slightly lower than 29·90 inches.

June.—This is the first summer month of the northern hemisphere, and the isothermals have now taken their summer positions. The highest isothermal, 95°, appears in three regions, viz. in India, in Central Africa, and in North America. The summer isothermals are thrust further than anywhere else into higher latitudes in North America, from Mexico in a N.N.W. direction as far as the head waters of the Yukon. Over the whole of this region the climate is drier, and sunshine consequently stronger, than over the regions to the east and west of it. The isothermals occupy also higher positions in latitude over the Europeo-Asiatic continent, unless where the influence of sheets of water draws them into lower latitudes; and the remarkable parallelism of the lines in the more strictly inland climates is one of their most marked features. The influence of the ocean in maintaining a low temperature as compared with the land in the east of Asia from the Sea of Okotsk to China, and in the east of North America from Labrador to south of Cape Hatteras, is more pronounced than in any other of the warmer months of the year.

The almost equal lowering of the isothermals in the northern portion of the Pacific on each side of Behring Straits is very remarkable, and is in striking contrast to the totally different distribution of temperature which obtains in the same latitudes of the North Atlantic.

Mean temperatures under the freezing point are now wholly within the Arctic Circle.

The changes in the distribution of the pressure are a diminution over the whole of Asia, amounting to about two-tenths near the centre of the continent; all Europe, except the northern part of Scandinavia and Italy, Switzerland, the southern half of France, and the Peninsula; all North America, except the extreme south-east and the extreme north-west of the continent; and in the southern hemisphere, in New Zealand and the extreme south of Australia. Elsewhere pressure has risen, the greatest increase being in the Atlantic from Spain westward to long. 30°, and in the south of Africa. One of the most widespread changes in the distribution of pressure occurs from May to June, which ushers in the summer months of the northern hemisphere. It embraces nearly all the southern hemisphere, the Atlantic south of lat. 55° N., the increase flowing over so as to cover parts of Europe and North America.

The anticyclonic regions of high pressure are the four in the North and South

Atlantic and Pacific immediately to the west of the continents, to the west of Australia, and other satellite anticyclones in Australia, South Africa, and South America. The best marked of these is the one in the North Pacific, where the mean pressure is 30·30 inches, and the least in Australia, where the mean is only 30·05 inches; but even in this last case the winds afford a well-defined illustration of the anticyclonic weather conditions in this part of the globe at this season, inasmuch as they blow outward upon the sea on all coasts.

One of the most sharply marked cyclonic areas of low pressure which occurs in this month is in south-western Asia, where pressure falls to a mean of 29·45 inches, and the barometric gradient from the Straits of Ormuz to the Caspian Sea is one of the steepest mean gradients that occur anywhere at any season. The next best marked cyclonic region is that in North America, and others much less marked appear between Iceland and Labrador, in Scandinavia, Spain, and in the eastern equatorial region of the Pacific. It is also to be noted that the equatorial low pressure between the two anticyclonic regions of the Atlantic is now less marked and greatly contracted in breadth.

July.—This is the typical month of the summer of the northern and of the winter of the southern hemisphere. The three regions in Asia, Africa, and North America, enclosed in June with the isothermal of 95°, and marking off the hottest regions of the globe in that month, cover now a wider extent, and include maximum temperatures a few degrees higher, indicating absolutely the highest mean temperatures that occur anywhere or at any season.

Among the most interesting features of the climates of restricted regions shown by the isothermals may be enumerated the relatively low temperature of Nova Scotia, the coast of Morocco, Burmah, and Victoria in Australia; and the relatively high temperature of the eastern division of India sheltered from the summer monsoon, and the inland regions of Scandinavia, Spain, Italy, and Greece. The influence of the Red Sea in these months is conspicuously seen in maintaining a low temperature, and thereby breaking the continuity between Asia and Africa of the isothermals of 90° and 95°. The crowding together of the lines in California and between the Bay of Biscay to the south of Algiers is very remarkable.

The more important changes of the distribution of the pressure are an increase over the southern hemisphere generally, with very slight exceptions in South Africa, New Zealand, and the south of South America; India, except the north-west; Japan; a patch of Europe, extending from the north of Spain to Hungary; the south-western half of the North Atlantic, and the continental portions of North America from the Gulf of Mexico north-westward to lat. 55°. Elsewhere pressure has diminished, but particularly over Asia and Europe, except the regions mentioned above, the northern half of the North Atlantic, and nearly the whole of British America.

In this month the pressure of the northern hemisphere, taken as a whole, falls to the annual minimum. If 29·95 inches be accepted as the mean pressure of the atmosphere over the globe, then the whole of this hemisphere, excepting the anticyclonic regions of the Atlantic and Pacific, has a mean pressure below the average. This great seasonal depression has its centre marked off by the isobar of 29·40 inches, extending from Mooltan to Muscat, and is absolutely the lowest continental pressure occurring anywhere or at any season. This great depression, which may be roughly regarded as coterminous with the land of the northern hemisphere, may be justly considered as ruling the climate and weather of this half of the globe during the summer months.

Subordinate centres of low pressure are to be seen in North America, between South Greenland and Hudson Bay, south of Iceland, in Scandinavia, in Spain, and in the valley of the Po, the last four being, however, comparatively slight. In America the lowest isobar is 29·75 inches. In Africa the increased heat seems to result in a widening apart of the isobars from the Red Sea to Sierra Leone, rather than in the formation of any distinct cyclonic centre.

In this month pressure in equatorial Atlantic, between the anticyclonic regions north and south of it, reaches its annual maximum, not falling as low as 29·90 inches.

In addition to the four anticyclones in the Atlantic and Pacific, anticyclones appear also to the west of Australia, in South Africa, and in Australia, in the last case reaching the maximum for the year. In the southern hemisphere, about lat. 30°, pressure rises over long stretches to or above 30·20 inches; and nowhere, except in the comparatively short distance from long. 170° E. to long. 140° W., does it fall below 30·00 inches. It is to this belt of high pressure that the part of the air which has been removed from the continents of the northern hemisphere has been transferred.

In January the highest mean pressure in Asia is a little more than 30·50 inches in the upper valley of the Amur and the region to the south-west of it; whereas in July the lowest pressure, 29·40 inches, is at a considerable distance from the above, being located in the valley of the Indus and south-westwards to Muscat. The difference of pressure between these two extreme months is thus fully 1·10 inch, or fully a thirtieth part of the entire barometric pressure, nearly the whole of the difference being occasioned by the difference of temperature of the two months. In North America the difference of pressure of January and July is only 0·45 inch, and in Australia the difference is nearly the same.

In the remarks on January it was pointed out that the centres of maximum pressure and minimum temperature, which, Antarctic regions being excepted, are respectively these maximum and minimum data for the globe for any season, are far from occupying the same geographical area. But in July the regions of minimum pressure and maximum temperature are virtually coincident. In this region the climate is remarkably dry and rainless, or nearly so, and substantially the same climatic characteristics

distinguish the more restricted regions of low pressure in the United States, Scandinavia, Spain, and North Italy. The point is of considerable importance in atmospheric physics, as showing that when the sun's heat is strongest cyclonic areas of low pressure are generated in dry climates; whereas in winter, in the higher latitudes, cyclonic areas are formed in humid and rainy climates.

One of the most remarkable illustrations of the respective influences of land and water on the courses of the isobars is seen at this season in the higher pressure maintained from the Straits of Gibraltar eastwards to the Sea of Aral by the extensive sheets of water for which this region is so remarkable. The crowding, widening, and deformation of the isobars in the different parts of the region is curious and highly instructive. On the other hand, the diminution of the pressure shown by the isobar of 29·80 inches immediately to the north in eastern Russia, where there are no water surfaces, is equally striking.

As Australia is an island sufficiently large to show the climatic features of a continent, it is interesting to note in connection with the anticyclone overspreading it at this time, that on all coasts the winds blow outward from the land seawards. This, therefore, is the dry season of Australia.

One striking feature of the oceanic anticyclones deserves attention. The isobars crowd more together on their eastern sides, where they press upon the continents adjoining, than on their western sides, where they are prolonged through their respective oceans. The prevailing winds of continental coasts adjoining anticyclonic regions are usually dry for two reasons; they advance from higher to lower, and therefore warmer latitudes, and they have traversed the evaporating surface of the ocean but a comparatively short way since their descent from the higher regions of the anticyclones. The dry climates of California, Peru, Morocco, and south-west of Africa at this time may be referred to as illustrations.

Quite different is it with the winds which blow through the West Indies, the Gulf of Mexico, and thence northwards through the United States. These winds having traversed a large extent of the ocean, distribute over these islands and States a generous and rarely failing rainfall, thus rendering the United States one of the uniformly best watered regions of the globe. Similarly the valleys of the Amazon and other rivers in the north of South America have a large rainfall.

As regards rainfall, southern and eastern Asia is, perhaps, the most remarkable region of the globe. The isobars of July show this at once. If a line be drawn marking the path of highest pressure from Durban in South Africa eastwards through the Indian Ocean and Australia, and thence out through the Pacific by New Caledonia to beyond the Sandwich Islands, then the whole of the Indian and Pacific Oceans between this line and the continent is traversed by winds which blow home on and into Asia during the summer months. Hence the prevailing summer winds arrive on

the coasts laden with the moisture of the oceans they have crossed, the result being the large rainfall of southern and eastern Asia. The heaviest of these rains are where mountain ranges lie across the path of the monsoon, and they penetrate farthest inland where the river valleys lie approximately in the course of the monsoon.

The July isobars of India are of more than ordinary interest, implying, as they do, the utmost practical advantages to the empire. From Cutch southward pressure is everywhere higher in the west than in the east of the same latitudes, represented by the south-easterly slant of the lines as they cross India. The difference is about half a tenth of an inch, and the same difference also holds good in Ceylon. The consequence of this peculiarity in the distribution of the pressure is that the summer monsoon blows more directly from the ocean than would have been the case if the isobars had lain due west and east. A much more important consequence, however, follows from the location of the region of least pressure in the valley of the Indus, so that in the valley of the Ganges, and in the north of India generally, pressure diminishes steadily from east to west,—from Assam, up the Ganges, and westward to Jacobabad on the Indus. The inevitable result of this inversion in the manner of the distribution of the pressure is that the winds are no longer south-westerly, but they become southerly over the Bay of Bengal, and thereafter deflected into E.S.E. winds blowing up and filling the whole valley of the Ganges, and distributing in their course a generous rainfall over this magnificent region. If winds there had been south-westerly, the rainfall would have been meagre and inadequate, owing to the intervention of the Western Ghauts between the sea and the Ganges.

It will be observed that the low-pressure system of Asia and the anticyclonic system of high pressure of the Atlantic are connected by what is virtually an unbroken broad belt of westerly winds over Europe and western Asia, bearing with them much vapour from the Atlantic, to which is due the summer rainfall of this part of the old continent. As they advance farther into Asia they take a northerly direction as they turn towards and blow round upon the region of low pressure in the Punjaub. Since, as they assume a northerly direction they blow into hotter regions, it follows that rain ceases to fall, and the climates are among the driest and hottest anywhere on the earth.

It also follows that Japan is one of the more highly favoured regions as regards its rainfall, depending as it does on the large extent of the Pacific to the south-east, over which the summer monsoon must blow before reaching the Japanese coasts.

The same principles are illustrated by the direction of the prevailing winds and distribution of the rainfall over and around the more restricted area of low summer pressure in North America. On the west side of this low-pressure area the Pacific anticyclone closely presses with its crowded isobars and arid northerly winds; whilst on the east side lies the higher pressure with its more open isobars and moist southerly

winds. The result is a close proximity of widely diverse climates as regards cloud, rainfall, and temperature.

The following Table gives the monthly average rainfall from a selected number of places within and contiguous to this low-pressure area :—

Mean Rainfall in the Western Divisions of the United States and of Canada.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
Fort Yuma, Ariz., .	·35	·40	·14	·10	·00	·00	·31	·63	·56	·19	·32	·29	3·20
San Diego, Calif., .	2·05	2·36	1·50	·94	·40	·07	·02	·18	·04	·41	·73	2·09	10·80
Los Angelos, ,, . .	2·70	3·50	2·95	2·15	·45	·18	·03	·02	·16	·51	·44	3·33	16·42
San Francisco, ,, . .	5·00	3·64	3·04	2·39	·62	·30	·02	·01	·15	1·22	3·00	4·75	24·14
Sacramento, ,, . .	4·21	3·06	3·27	3·48	·62	·25	·00	·00	·27	·90	2·09	4·04	22·19
Roseburg, Oreg., . .	6·20	4·56	3·44	3·02	1·82	·97	·61	·31	·86	2·83	3·79	6·43	34·84
Mendocino, Calif., . .	9·90	8·91	7·36	4·77	1·31	·39	·05	·03	·47	2·57	5·81	8·26	49·82
Portland, Oreg., . .	7·05	7·31	6·36	3·31	2·44	1·71	·72	·67	1·82	4·53	6·79	8·36	51·07
Astoria, ,, . .	11·17	7·80	3·77	3·54	4·94	1·88	1·16	·72	4·90	4·78	7·01	11·14	62·81
Boisé City, Idah., . .	2·42	1·28	1·72	1·14	1·34	·69	·17	·18	·36	·88	1·28	2·18	13·74
Walla Walla, Wash., .	3·45	1·29	1·06	1·66	·67	·73	·02	·12	·06	1·95	·78	3·16	14·95
Tatoosh Is., ,, .	14·87	9·87	5·21	3·57	4·45	2·96	2·81	3·44	7·10	7·16	13·08	14·72	89·24
Olympia, ,, .	8·59	8·80	4·81	3·79	2·53	1·17	·89	·72	3·08	5·05	7·04	9·61	56·08
Victoria, Brit. Col., .	5·69	3·64	2·56	1·20	·91	·77	·40	·52	2·01	2·86	4·00	4·96	29·53
Fort Simpson, ,, .	9·01	9·23	7·65	7·47	4·15	3·90	4·31	7·02	11·96	15·01	13·54	6·25	99·50
New Westminster, ,, .	7·78	8·37	6·99	3·86	3·27	2·79	3·56	2·03	1·92	6·70	5·05	12·65	64·98
Lillooet, ,, .	1·75	1·12	1·22	·66	1·34	1·53	1·01	·97	1·18	·98	1·39	2·26	15·41
Spencer Bridge, ,, .	1·70	0·28	·37	·16	·52	4·15	3·25	5·30	3·80	2·39	2·33	1·53	25·78
Fort York, P.R.L., .	·59	1·59	·87	·24	·72	·80	·63	·56	1·06	·01	·49	·67	8·23
Moose-Factory, ,, .	3·00	·93	1·92	1·24	2·22	3·62	3·37	3·09	3·87	2·06	2·08	2·19	29·59
Marten Falls, ,, .	2·50	1·50	·00	·00	4·37	5·91	3·08	2·58	2·22	3·48	1·17	2·60	29·41
Nepignon, Ont., . .	2·32	2·65	1·10	1·30	3·09	2·13	3·76	2·74	1·41	4·00	1·90	1·70	28·00
Winnipeg, Manit., .	·58	1·00	1·03	1·31	2·05	3·20	2·58	2·51	1·83	1·37	·92	·99	19·37
Chipewyan, Atheb., .	·89	·63	·74	·31	·45	·98	1·79	·74	1·37	1·35	·52	·81	10·58
Dunvegan, ,, .	1·09	1·06	1·90	·76	2·24	3·07	1·37	2·94	1·65	1·46	1·07	1·40	20·01
Qu' Appelle, Assin., .	·41	·51	·45	1·05	1·39	2·40	1·90	1·47	·92	·45	·58	·77	12·30
Medicine Hat., ,, .	·31	·38	·44	·57	·91	3·27	1·33	·94	·90	·45	·42	·40	10·32
Edmonton, ,, .	1·01	·83	·64	·49	2·01	2·25	2·83	·74	1·01	·93	·23	·68	11·65
F. Benton, Mont., . .	·80	·52	·73	·96	2·39	2·16	1·82	1·08	1·04	·19	·78	·64	13·71
F. Buford, Dak., . .	·69	·52	·43	1·45	1·94	2·88	2·31	1·15	·69	·93	·41	·82	14·22
Cheyenne, Wy., . .	·28	·26	·61	1·23	2·14	1·51	1·66	1·52	·89	·64	·31	·21	11·26
Salt Lake City, Utah, .	1·46	1·36	2·00	2·33	2·00	1·04	·54	·83	·96	1·72	1·76	1·49	17·40
Winnemucca, Nev., .	1·01	1·01	·75	1·07	·83	·85	·18	·09	·31	·70	·93	1·14	8·87
Pike's Peak, Col., .	1·72	1·45	2·11	3·71	3·89	1·84	4·29	3·72	1·77	1·48	1·80	1·46	29·24
Santa Fé, N. Mex., .	·52	·65	·58	·68	·84	1·16	3·09	2·94	1·51	1·03	·87	·82	14·69
El Paso, Tex., . .	·58	·44	·49	·18	·40	·54	2·85	2·23	1·21	1·37	·48	·67	11·44
F. Gibson, Ind. Ter., .	2·03	2·28	2·52	4·23	4·44	4·13	2·97	2·69	2·56	3·55	2·92	2·16	36·55
North Platte, Nebr., .	·52	·35	·61	1·84	3·16	3·51	2·71	2·48	1·34	1·26	·43	·74	18·95
Omaha, ,, . .	·55	·83	1·50	3·55	4·98	6·46	6·17	3·59	3·53	3·15	1·32	1·01	36·64

The stations are separated into two distinct groups by a line made to pass in a north and south direction through the centre of the low-pressure area. To the west of the line the summer rainfall is either *nil* or small, whereas to the east of it the rainfall reaches the annual maximum in this season. The influence of this low pressure is to augment the summer rainfall, at least as far eastward as the Mississippi. Farther north on Hudson's Bay and the N.-W. Territories of Canada the summer rainfall is for the same reason also large, the amount being in a great degree to be traced to the large evaporation from Hudson's Bay conveyed by the prevailing winds southwards and distributed over the Territories. The rapid increase of the rainfall on the seaboard from the Columbia River northwards is remarkable, the amounts for July being 1·16 inch at Astoria; 2·81 inches at Tatoosh Island, near Cape Flattery; 3·56 inches at New Westminster; and 4·31 inches at Fort Simpson, to the north-east of Queen Charlotte Island. At all coast stations to the north of San Francisco the winter rainfall is very large. The greatest falls occur at Tatoosh Island, Fort Simpson, and Astoria, and the heavy rains set in as early as September.

August.—The declining influence of the sun is now decidedly felt in the higher latitudes and in the drier continental climates. The temperature of a considerable portion of the Arctic regions has now fallen below the freezing point. At Barnaul, in Siberia, temperature falls from 68°·6 in July to 62°·5 in August, and at Werkojansk, where the greatest known cold is recorded in the winter, the figures are for July 58°·6 and August 48°·7.

On the other hand, the temperature of the oceans, as well as in many strictly insular situations of the northern hemisphere, rises to the annual maximum in this month. At Astrabad, on the Caspian Sea, the means are for July 81°·7 and August 83°·4, at Nagasaki 77°·7 and 79°·8, and at Bellisle 48°·8 and 50°·9. The influence of extensive water surfaces in maintaining a higher temperature towards the close of summer is well illustrated by the air temperatures of the Atlantic and Red Sea.

The high temperature of the Atlantic on the one hand, and the upwelling of the cold deep water to the surface off the north-west coast of Morocco on the other, result in the singular positions of the August isothermals of that ocean. Similar low temperatures are also seen in each case where the four great anticyclonic areas of high pressure in the Pacific and Atlantic press on the continents, the lowering influence being increased by the prevailing winds passing into lower latitudes.

The changes in the distribution of the pressure are an increase over the whole of Asia and Europe, except the countries in the south-west of the latter continent, the increase being greater in those regions where the most marked fall in the temperature is proceeding; over North America, except the extreme western and extreme southern regions; and in South America, to the south of the Argentine Republic. On the other hand, pressure has fallen over France, Italy, Spain, and Portugal; over the Atlantic,

except to eastwards of the New England States as far as long. 45° W.; and over Australia, and nearly the whole of Africa and South America. The more remarkable of the resulting changes is the reappearance, in the neighbourhood of Spitzbergen and North Greenland, of the high pressure which overspreads nearly the whole of the Arctic regions during the colder half of the year. In Spitzbergen, pressure is now slightly above the general average of 29·95 inches. The high pressure characteristic of continents during the winter months has disappeared from South Africa; but is still shown in Australia, reduced, however, about half a tenth of an inch.

The anticyclone of the North Atlantic covers nearly the same extent as in the previous month; but as pressure over it is generally half a tenth of an inch less, and as in Asia to the north of the high tableland of the interior it has risen a tenth and a half, the gradient for westerly winds is greatly reduced. Climatologically this is, perhaps, the most important change, next to that of the temperature, that occurs in August. The gradient for westerly winds from the Atlantic being reduced, these winds are correspondingly lessened in force, and the amount of the rainfall is diminished to the east of long. 20° E.

September.—In this month the low temperature of the Arctic regions spreads and deepens, and in the interior has fallen to 20°. The highest isothermals are now 90° in Asia and Africa, and 85° in North America and the north of Australia. The comparatively high temperature of the extensive tropical regions of the Pacific and Atlantic, where the difference of temperature is very slight, is still maintained. The other outstanding feature of the temperature is a greatly more rapid fall now in progress over the land as compared with that over the ocean. Thus, while in mid-Atlantic about lat. 52° 30′ N. and long. 32° 30′ W., the mean temperature of August is 57°·6, and of September 55°·2, on the continent the means are 64°·9, and 58°·7 at Berlin, 62°·5 and 51°·2 at Barnaul, and 48°·7 and 32°·7 at Werkojansk. These changes altogether alter the temperature relations of the different regions of the northern hemisphere to each other, and it is these changed relations which bring about the vital change in the peculiar distribution of the pressure which sets in with the autumn months.

Over the whole of Asia and Europe, except the British Islands and north-western Norway, pressure has risen, and most largely where temperature has fallen to the greatest degree, unless the region is situated so as to be affected by an extensive low pressure area now being formed; the whole of North America, except Labrador, and Alaska, and British Columbia; the northern half of Africa; and in the south of Australia and south of South America. Everywhere else pressure has fallen, notably so in the north-eastern part of the Pacific and of the Atlantic, and part of the continents adjoining, where the winter cyclonic low pressure of the regions are rapidly forming, the isobars of the North Pacific now showing a pressure of 29·70 inches, and of the North Atlantic of 29·75 inches.

As pressure has still further fallen in the anticyclone of the North Atlantic and risen rapidly in Asia, the difference in pressure is now so small that the westerly winds from the Atlantic towards the centre of the old continent may be considered at an end for the year. But the cyclonic area over the North Atlantic has now extended and deepened to such an extent as to rule the winds of western and northern Europe. With the greater prevalence of these south-westerly winds the rainfall of these regions is largely increased, reaching even to the annual maximum in Denmark and a considerable portion of Finland and Sweden.

October.—The mean temperature has fallen to $-5°$ in the extreme north of Greenland, and except a portion of the North Atlantic and the north of Scandinavia temperature is now below $32°$ over the whole of the Arctic regions. This low temperature descends to lat. $54°$ on the coast of Labrador, and to the same latitude in eastern Siberia. The abnormally high temperatures have now altogether disappeared from Spain, Greece, and Scandinavia, and, as regards the last region, the isothermals show that abnormally low temperatures from the north-east begin to overspread it.

The fall of temperature in the interior of Asia is very great, being from $20°$ to $30°$ over a wide area. At Werkojansk the fall is from $32°{\cdot}7$ to $-0°{\cdot}6$, or a fall of $33°{\cdot}3$. On the other hand, in Egypt, Syria, and over the Red Sea it is very small.

The highest isothermals are $90°$ in North and South Africa and in the north of Australia, and $85°$ in Brazil and Central America.

Pressure has fallen over the whole of the southern hemisphere, over the Atlantic, Greenland, and the western half of Europe, to the west of a line drawn from Corfu to Helsinfors, and thence north-eastwards to Franz Josef's Land; and the cyclonic region of the North Pacific has further extended and deepened. Everywhere else pressure has increased, particularly over Asia, being the maximum monthly increase that occurs in any month anywhere over the globe. In the centre of the continent the increase is from 0·25 to 0·30 inch. Thus, in passing from September to October, pressure diminishes over all those regions where the temperature, relatively to that of immediately surrounding regions, is higher in October than it was in the month previous; but it increases over those regions where temperature is relatively lower, and most so just over those regions where the temperature is now most strikingly low as compared with adjoining regions.

The area in the Arctic regions covered by a pressure exceeding 29·95 inches, the average for the globe, is now largely extended. In addition to the four anticyclones in the Atlantic and Pacific, anticyclones appear in Asia, where the isobars show a pressure of 30·20 inches; in the Indian Ocean, with a pressure equally high. There are also less marked ones in the Pacific Ocean midway between South America and Australia; in the United States to the east of the Mississippi; and in Spain.

The cyclonic areas of low pressure in the north of the Atlantic and Pacific have

further developed and extended, and in each case the isobars show a pressure of 29·60 inches. South-westerly winds have increased in frequency and force over western Europe, and in the west of America to the north of the Columbia River; whilst north-westerly winds have equally increased over Canada and the more northern portion of the United States, and over the east of Asia. In western Europe the rainfall is very largely increased, the maximum monthly fall for the year occurring in Norway, the British Islands, with the exception of the strictly western districts, and over large portions of France and Spain. On the coast stations of British Columbia the rainfall is also heavy, rising to 15·01 inches at Fort Simpson on a mean of the two years 1887–88, and at Sitka the mean is 11·83 inches. On the other hand, the north-westerly winds have largely increased the cold and dryness of the climates of the eastern regions of Asia and North America. The low summer pressure of India is now represented by a shallow depression, having its centre in the Bay of Bengal, where the lowest isobar indicates a pressure of 29·80 inches. The winds accompanying the depression of this transition month from the summer to the winter monsoon are extremely interesting, and the differences shown by the prevailing winds of the Bay of Bengal and the Arabian Sea are very striking.

Low pressure systems also occur in Central Africa, in the north of South America, and thence westward through the Pacific to longitude 140° W.; and again in the Pacific between New Guinea and the Sandwich Islands. There is also a slight but wide-spread depression over the Mediterranean, and the influence of the higher temperature maintained by the Black and Caspian Seas is well seen in the deformation of the isobars in their neighbourhood.

November.—In the central parts of the Arctic regions the isothermal of −15° encloses an extensive area, and the isothermals droop in lower latitudes through eastern Siberia, and in North America in the direction of Lake Winnipeg. In Siberia, a centre of still lower temperature is now formed round Werkojansk, where temperature has fallen to −39°·5, the mean of November being thus 38°·9 lower than that of October. The most southerly position of a mean temperature of 32° is to the south of Wladistok, about lat. 42° N. The protrusion northwards of high temperatures along the west of Norway, and the protrusion southward of low temperatures through the centre of Scandinavia, are among the most striking contrasts in the distribution of the temperature in November. The higher temperature of the Red Sea, the curves of the isothermals in America from Mexico to the head waters of the Missouri, the irregular courses of the isothermals over the seas of southern Europe, the courses of the isothermals of 45°, 40°, 35°, 30°, and 25° over Europe as compared with the contours of the Continent, and the distribution of temperature in India, are prominent features in the climatologies of the month.

The highest isothermals are 95° in the north of Australia, 90° in South Africa, and 85° in South America and Central America. Owing to the distribution of the

pressure in Australia the winds of the district where the temperature has risen to 95° blow from the interior of the arid portion of this continent.

In this month pressure has continued to fall over the whole of the southern hemisphere. The low pressure in the north of the Pacific remains much as it was in October, except that it has extended over Behring Straits; the low pressure in the north of the Atlantic is nearly the same as in the previous month, except that it is several degrees of latitude to southward, and a subsidiary satellite depression has appeared to the north of Norway. Pressure has also fallen over the north-eastern half of the Atlantic as far as lat. 60° N.; but the most remarkable fall is that which occurs over all Europe, except in Spain and Portugal and in the west and south of France. This general fall of pressure over the north-eastern part of the Atlantic, and to the eastward over Europe to long. 45° E., taken in connection with a simultaneous large increase over Iceland and Greenland, gives the explanation of the secondary maximum of easterly and northerly winds which prevails over a large portion of Europe in November, with the reduced rainfall which accompanies them.

There are other low-pressure centres in the Indian Ocean from Borneo to Ceylon, in Africa, in the regions of the lower Amazons, and in the north-west of Australia. The peculiarities of the distribution of the pressure over the seas of southern Europe are even more pronounced than in October, showing that distribution is in the strongest manner mainly influenced by the irregular distribution of land and water over the same regions.

Of the four anticyclones of the two great oceans, the most pronounced is that to the westward of the heated plains of the Argentine Republic, and the least that in the North Atlantic.

The anticyclone of Asia indicates a pressure of 30·40 inches, and its system of isobars and outflowing winds on all sides shows that it has now acquired its strongly marked winter characteristics. The other anticyclones are in the Indian Ocean to the west of Australia, in the Pacific to the north-east of New Zealand, a subsidiary one being also in Spain. The courses of the isobars of 29·95, 29·90, and 29·85 inches from the north-east of Africa to Tonkin illustrate in a remarkable manner the influence of the ocean in lowering, and of the land in augmenting, pressure at this time when temperature is rapidly falling. Over all India the surface winds are northerly, but the different directions in different districts possess great interest in their relations to the undulating courses of the isobars.

From the greater prevalence of northerly and easterly winds the maximum rainfall for the year occurs in November nowhere in Europe, except in the Mediterranean region marked out by the isobar of 30·00 inches, and eastward so as to include Greece.

December.—The mean temperature of the whole of the earth's surface enclosed by the Arctic Circle is under 32°, and the isothermals of –25° embrace a large portion of this

region. The low temperature region in Siberia shows a mean temperature of $-55^\circ{\cdot}5$ at Werkojansk, near its centre. In North America, near the magnetic pole, temperature falls a little below -25°.

The influence of oceanic currents on the isothermals is strikingly seen through the centre of the Atlantic, and thence round the North Cape into the Arctic Ocean eastwards as far as the Liakov Islands. The influence of Hudson's Bay, the North Seas, and the Baltic with its connected seas, are particularly well illustrated in this month; and, on the other hand, the influence of the land in lowering the winter temperature is equally well seen along the centre of the unbroken land surface of Europe from Moscow to Lisbon.

The observations made in December by various expeditions to Antarctic regions show a mean temperature of 25° between longs. 160° E. and W., and similar low temperatures occur in this zone in the other summer months of the southern hemisphere, being in this respect quite different from the Arctic regions in summer where mean temperature does not fall below 35°, even though observations are available from much higher latitudes. The difference is, of course, due to the all but continuous covering of water, ice, or snow within the Antarctic Circle, whereas within the Arctic Circle there is a large proportion of land, and the Arctic Ocean is, besides, nearly altogether landlocked.

The Loffoden Isles and Werkojansk are approximately in the same latitude, yet their mean temperatures are respectively 30° and -55°, the difference being 85°. This shows in an impressive manner how the temperature does not fall according to latitude, but according to the distance to which the place is situated eastward and northward in the continent; where, at the same time, the air is calm, dry, and clear, and seldom reached by winds from any ocean.

Another feature of the isothermals is their openness in those regions of Europe and western Asia, where south-westerly winds prevail, and their crowded condition over the higher plateaux to the south to which these winds do not reach, and where the air is drier and calmer.

The highest isothermals are 95° in the north of Australia, 90° in South Africa, and 85° in two districts in South America separated by the valley of the Plata. The crowding of the isothermals in South America and South Africa is characteristic of all regions where in summer the air is dry, and where the adjoining coast is swept by winds passing into lower latitudes.

Pressure has fallen everywhere over the southern hemisphere, and over Turkey, Russia, Scandinavia, and thence westward across Iceland, Greenland, and Arctic America; but elsewhere it has risen.

A much greater expanse of the Arctic regions is overspread by a high pressure; the centre of the anticyclone of Asia shows now a pressure of 30·50 inches; that of North

America 30·20 inches; and those of the Indian Ocean between South Africa and Australia, to the west of South Africa and to the west of South America, are particularly well defined, being separated from each other by pressure under the general average. The result is the transference of a large mass of the earth's atmosphere from the southern to the northern hemisphere, and from the ocean to the land surfaces of the northern hemisphere; in other words, the transference is from those regions of the globe where temperature is relatively high to where, with respect to immediately surrounding regions, it is relatively low.

The cyclonic areas of low pressure in the North Atlantic and Pacific have now virtually acquired their winter extension and depth. In November the difference in pressure between the centres of the North Atlantic anticyclone and cyclone is 0·40 inch, but in December the difference increases to 0·60 inch, or a half more. With this increased gradient, the Atlantic south-westerly winds increase in strength and frequency, and precipitate over western Europe a much heavier rainfall, augmented by meeting land of a relatively lower temperature than in the previous months. Thus the maximum rainfall of the year occurs in this month and January following, when quite similar meteorological conditions prevail over the whole of the strictly western division of the Peninsula, the extreme north-west of France and south-west of England, and the more western districts of Ireland and Scotland.

Low-pressure areas also occur in South Africa, the valley of the Amazon, and from the north-west of Australia to Java. A lower pressure now appears in the equatorial region of the Atlantic between the two anticyclones of that ocean than prevails there in any other month.

A singular distribution of pressure is well seen this month in the Mediterranean, illustrating the relation of the Italian peninsula to this area of low pressure. This peculiarity is observed through all the winter months; but as the isobars are drawn only to half-tenths, it does not appear in so pronounced a manner in the other months. The same peculiarity is shown in the relations of India to the isobars of that region as compared with the isobars of the Arabian Sea and Bay of Bengal,—a feature still more decidedly shown in this than in the previous month.

Abnormal Pressures and Temperatures.—The isobars, isothermals, and winds detailed are shown in the normal atmospheric conditions of the different months. It not unfrequently happens, however, that the actual weather of individual months differs widely from what these normals indicate. The most important weather changes, as affects human interests, are those which depend on wind, temperature, and rain; and as these again are most intimately bound up with the actual distribution of pressure at the time, it is the last that really furnishes the key to weather changes.

As good an example as could be adduced to show these changes is offered by the weather conditions of December 1878. This month was remarkable for unusually

abnormal weather over the whole globe. If a line be drawn from Texas to Newfoundland, across the Atlantic, the north of France and Germany, thence round by south-east through the Black Sea, the Caucasus, India, the East Indian Islands, and Australia, to the south of New Zealand, it will pass through a broad extended region where pressure was throughout considerably below the mean of December, and this prolonged area of abnormally low pressure was still further deepened in various regions along the line. Another line passing through the Philippine Islands, Japan, Manchuria, Behring's Straits, and Alaska marks out another extensive region where pressure was uninterruptedly below the mean.

On the other hand, pressure was above the average of the month, and generally largely so, over the United States to west of longitude 90°, over Greenland, Iceland, the Faroes, Shetland, and a large part of the Old Continent, by a line drawn from Finland round by Lake Balkhash, Canton, and Pekin, to the upper region of the Lena. Another area of high pressure extended from Syria through Egypt and East Africa to the Cape; and part of a third area of high pressure was seen in the North Island of New Zealand.

As regards North America, the greatest excess of pressure, about 0·20 inch above the mean, was in the valley of the Columbia, from which it gradually fell on proceeding eastwards to a defect from the mean of 0·15 inch near Lake Champlain and to northward, rising again to near the mean in the north of Nova Scotia. To the north and north-east exceedingly high pressures for these regions and for this month prevailed, being 0·635 inch above the mean in Iceland, 0·50 inch in the south of Greenland, the excess diminishing on advancing northwards along West Greenland.

West Greenland being thus on the west side of the region of high pressure, which for the time overspread the northern part of the Atlantic, and on the north-east side of the area of low pressure in the United States and Canada, strong south winds set in along that coast, and the temperature at the four Greenland stations, proceeding from south to north, rose to 1°·1, 8°·8, 12°·1, and 14°·4 above the means, being in accordance with the relations of the distribution of pressure and temperature everywhere shown to prevail by the mean pressure and temperature charts of the months. Again, as the centre of lowest pressure was about Montreal, strong northerly and westerly winds predominated to westward and southward, and consequently temperature was there below the average, the deficiency at St. Louis and Chicago being 9°·5; and the winds being northerly and easterly in California, temperature was there also under the mean.

On the other hand, in the New England States, the greater part of the Dominion of Canada and West Greenland, temperature was above the average. Pressure was much higher at St. Michael's, Alaska, than at St. Paul's to south-westward; and hence while temperature at St. Paul's was 2°·9 below the normal, it was 12°·0 above it at St. Michael's, where strong winds from the south prevailed.

As Iceland was on the north-east side of the patch of high pressure overspreading the north of the Atlantic, northerly winds prevailed there, and temperature consequently fell 7°·2 below the mean, presenting thus a marked contrast to the high temperature in West Greenland in the same month. In Europe, the region of lowest pressure occupied the southern shores of the North Sea, thence extending, though in a diminished degree, to south-eastward. It inevitably followed that over all western Europe winds were N.E., N., and in the south-west of Europe, W.; and everywhere from the North Cape to the north of Italy temperature was below the normal, in some places greatly so, the defect being 10°·4 in the south of Norway and 12°·2 in the south of Scotland.

On the other hand, on the east side of this area of low pressure winds were southerly, and consequently temperature was high. In some parts of Russia it rose to 15°·0 above the mean, and over the greater part of European Russia the excess exceeded 9°·0. This region of high temperature extended eastwards into Siberia as far as the Irtish, being quite coterminous with the western half of the anticyclonic region of high pressure which covered central Siberia. But over the eastern half of this Siberian anticyclone northerly winds prevailed, with the necessary accompaniment of low temperature over the whole of eastern Asia, the defect being 6°·8 at Nertchinsk and 9°·0 at Chabarowka on the lower Amur.

Here again, as in America, Greenland, and Iceland, places with the atmospheric pressure equally high presented the strongest contrasts of temperature, just as they happened to be situated on the eastern or western sides of the anticyclones prevailing at the time. Thus at Bogoslovsk, on the Ural Mountains, pressure was 0·210 inch, and at Nertchinsk 0·154 inch, above the normals; but Bogoslovsk, on the west side of this anticyclonic region, had its temperature 15°·0 above, whilst at Nertchinsk, on the east side, it was 6°·8 below the average. At the former place winds were southerly, but at the latter northerly.

In this season the mean pressure falls to the annual minimum in Australia, but during December 1878 the usually low pressure was still further diminished. Pressure at this time of the year also falls to the minimum in the North Pacific and in the North Atlantic, and, as has been stated, the low pressure of these regions was also still further diminished. But in the case of the Atlantic, it was accompanied with a most important difference; the centre of least pressure, usually located to the south-west of Iceland, was removed some hundreds of miles to south-east, and a most unwonted development of extraordinarily high pressure appeared to the northward, overspreading the extensive region of Baffin's Bay, Greenland, Iceland, Farö, and Shetland. Now it was to this region of high pressure, in its relations to the low-pressure region to the south-east of it, that the extreme severity of the weather over the British Islands at the time was due. It is remarkable that with the exception of the high-pressure area about Greenland, and the displacement of the low-pressure area

of the North Atlantic to the south-east, the meteorological peculiarities which rendered the weather of December 1878 memorable over nearly the whole globe arose out of a distribution of the earth's atmosphere which was essentially the same that obtains at this season, but the usual irregularities in the distribution of the pressure appeared in more pronounced characters.

Mean Atmospheric Temperature and Pressure for the Year.—The distribution of the mean annual pressure may be regarded as representing the sum of the influences at work, directly and indirectly, throughout the year in increasing and diminishing atmospheric pressure and temperature.

The isothermal of -5° surrounds the north pole, and marks off the region where the annual temperature of the globe falls to the minimum, Maps XXV. and XXVI. The regions of highest mean annual temperature marked off by the isothermal of 85° occur in Central Africa, in India, the north of Australia, and Central America; but, except Central Africa, these areas are very restricted. Temperature is depressed in the greatest degree towards the eastern sides of the land surfaces of the continents as they stretch towards and into the Arctic regions. As regards the ocean, temperatures are low on the eastern coasts of the continents of the northern hemisphere and on the western side of the continents of the southern hemisphere. The effect of the more clouded condition of the atmosphere of intertropical South America as compared with Central Africa is well illustrated by the isothermals of these two extensive regions.

The most conspicuous example of the influence of ocean currents in raising the temperature is seen in the protrusion northwards of the isothermals over western Europe, due to the prevailing winds and widespread currents which there pass from lower to higher latitudes. The contrast the temperature of the east coast of America offers to that of Europe is very striking. A similar result, but in a greatly reduced form, is seen on comparing the east of Asia with the west of North America.

As respects land surfaces of tropical and sub-tropical countries, the highest mean annual temperatures are found in those regions where for a considerable portion of the year the climate is dry and practically rainless. The isothermals of Mexico and Brazil show in a striking manner the influence of dry and wet climates on the distribution of temperature in low latitudes. In this connection the crowding together of the isothermals in Africa and South America about latitude 30° S. is one of the most striking features of these lines.

The chart of mean annual atmospheric pressure shows two regions of high pressure, the one north and the other south of the equator, which pass completely round the globe as broad belts of high pressure. The belt of high pressure in the southern hemisphere lies parallel to the equator, and is of tolerably uniform breadth throughout, widening, however, in the longitudes of the anticyclonic regions of the Pacific, Atlantic, and Indian Oceans, and of the less pronounced anticyclone of Australia. The belt of

high pressure north of the equator has a very irregular outline, and exhibits the greatest differences as regards breadth and inclination to the equator. These irregularities wholly depend on the peculiar distribution of land and water which obtains in the northern hemisphere. The maximum breadth is reached over the continents of Asia and America; and, indeed, the area of high pressure may further be regarded as stretching across the Arctic region from the one continent to the other. The highest mean annual pressure, 30·20 inches, is attained in the anticyclonic region in the North Pacific. On the other hand, the belt of high pressure falls to the minimum in the Pacific immediately to the east of Japan, where it is less than 29·95 inches. It is also to be noted that pressure is nearly equally low in the east of the United States and parts of the Atlantic adjoining. About the same latitudes, both north and south of the equator, pressure is invariably high in the ocean a little to westward of all continents.

These two belts of high pressure enclose between them the comparatively low pressure of equatorial regions, through the centre of which runs a narrower belt of still lower pressure, towards which the trade winds on either side blow. This intertropical belt of low pressure exhibits several centres of still lower pressure. The most important and extensive of these includes India, the southern half of Arabia, and a large portion of Central Africa, where pressure falls below 29·80 inches; and over a considerable part of north-eastern India it falls under 29·75 inches. Over the larger proportion of the East India Islands pressure is also under 29·80 inches; and there are besides two small regions near the mouth of the Amazon and near Panama where pressure does not quite reach 29·85 inches.

Perhaps the most remarkable region of low pressure is in the Antarctic regions, which, remaining low throughout the year, plays the principal rôle in the wind systems bordering on and within the Antarctic Circle, with their heavy snows and rainfall, and in the enormous icebergs which form so striking a feature of the waters of the Southern Ocean. It is probable that over nearly the whole of the Antarctic regions mean pressure is at least less than 29·30 inches.

In the north polar regions pressure is lower than over the continents, but higher than over the oceans immediately adjoining. In the temperate and Arctic regions there are two strongly marked depressions—the larger covering the northern portion of the Atlantic and adjoining lands, and the other the corresponding portion of the North Pacific, the mean in each falling in the centre below 29·70 inches.

Now the whole of these areas of low pressure have the common characteristic of an excessive amount of moisture in the atmosphere. The Arctic and Antarctic zones of low pressure, and the equatorial belt of low pressure generally, are all but wholly occasioned by a comparatively large amount of vapour in the atmosphere. But as regards the region of low pressure in Southern Asia in summer, while the eastern half of the depression overspreading the valley of the Ganges has a moist atmosphere and a

large rainfall, the western half of it is singularly dry and practically rainless, and its central portion occupies a region where at the time the climate is one of the driest and hottest found at any season anywhere on the globe. Hence, while observation shows the vapour to be the most important and widespread of the disturbing influences at work in the atmosphere, the temperature also plays no inconspicuous part directly in destroying the equilibrium of the atmosphere; from which disturbance result winds, storms, and many other atmospheric changes.

Annual Range of the Mean Monthly Pressure.—This has been calculated from the sea-level pressures by simply subtracting the lowest mean monthly pressure from the highest, and entering the difference in its place on a map of the globe from which the lines of equal difference were drawn, as shown in the accompanying Fig. 3.

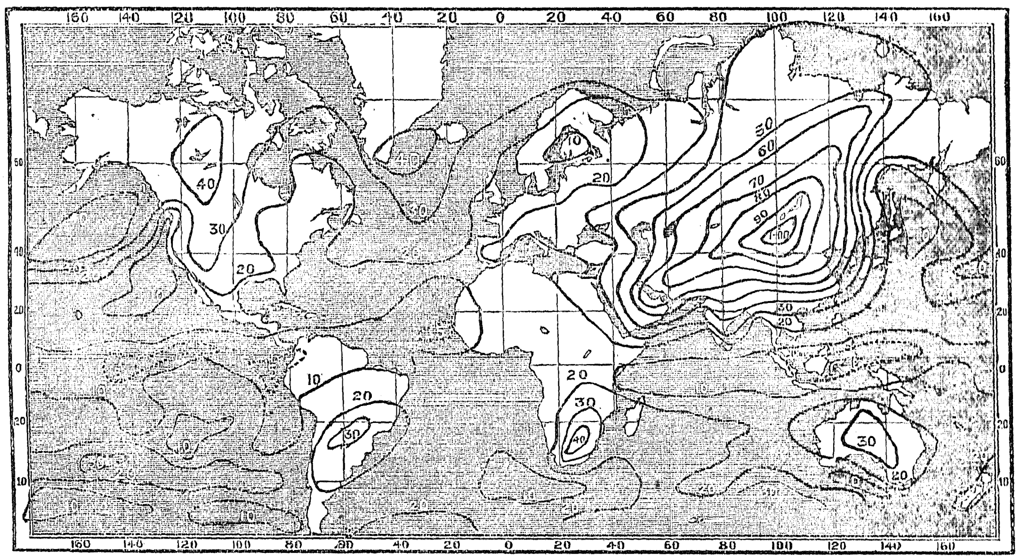


Fig. 3. Chart showing the annual range of the mean monthly pressure over the globe, expressed in hundredths of an inch.

The greatest difference occurs in the interior of Asia, near Urga, to the south-south-west of Lake Baikal, amounting to one inch. Thus in this region a thirtieth part of the whole winter pressure is removed during the summer months. In British America the difference is about 0·40 inch, and this is also the difference in South Africa. In South America and in Central Australia it amounts to 0·30 inch. These all occur in continents, and the largest difference is in the largest continent. On the other hand, in the North Atlantic, between Iceland and the south of Greenland, and again in the North Pacific to the south of Alaska, the difference is 0·40 inch; but in no other part of the ocean is there so large a difference. In these two cases it is wholly due to the exceptionally low winter pressure of these regions. In the southern hemisphere the two patches of greatest difference occur, one to the east of New Zealand, between 140° and 160° long. W., and the other in the Indian Ocean, to the south-west of Australia, from 80° to 115° long. E.

On the other hand, the least difference of the lowest and the highest mean monthly pressures, 0·05 inch, occurs in four isolated patches. These regions, indicating thus the greatest stability of mean pressure throughout the year, occur all in equatorial regions, viz. in the East Indian Archipelago; in the Pacific, from 150° to 105° long. W.; and again from 95° to 75° long. W.; and in the Atlantic to the west of Senegambia, extending only from about 10° of longitude and 6° of latitude. These are all included in a wide area, almost wholly restricted to intertropical regions, bounded by 0·10 inch, and stretching unbroken from the east coast of equatorial Africa eastwards across the whole of the Pacific, the north of South America, the Atlantic, and into Africa, as far as about 5° long. W. Other isolated patches, showing also the small difference of 0·10 inch, occur to the south-west of Australia, South Africa, and South America; in the South Pacific between 40° and 50° lat. S. and 130° and 180° long. W.; in the North Pacific to west and south-west of California; to the east of Sagalien and Japan; and in the Gulf of Bothnia and Finland.

This, perhaps, of all the annual phenomena disclosed by meteorology, presents the strongest contrast between the northern and southern hemispheres. The northern hemisphere, with its large masses of land, shows the maximum variability in the mean pressure through the months of the year. Indeed, in extropical regions the difference does not fall so low as 0·10 inch except in three insignificant patches. In the southern hemisphere, with its enormous breadths of ocean, the range shows comparatively small variability. It is only by the low pressures of the winter months, when temperature and humidity of the air over the northern portions of the Atlantic and Pacific Oceans are abnormally high, that the ocean may be regarded as contributing to the formation of a range of as much as 0·40 inch to the mean monthly pressures of the year.

The Isobaric Maps show, in the clearest and most conclusive manner, that the distribution of the pressure of the earth's atmosphere is determined by the geographical distribution of land and water in their relations to the varying heat of the sun through the months of the year; and since the relative pressure determines the direction and force of the prevailing winds, and these in their turn the temperature, moisture, rainfall, and in a very great degree the surface currents of the ocean, it is evident that there is here a principle applicable not merely to the present state of the earth, but also to different distributions of land and water in past times. In truth, it is only by the aid of this principle that any rational attempt, based on causes having a purely terrestrial origin, can be made in explanation of those glacial and warm geological epochs through which the climates of Great Britain and other countries have passed. Hence the geologist must familiarize himself with the nature of those climatic changes, which necessarily result from different distributions of land and water, especially those changes which influence most powerfully the life of the globe.

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APPENDICES.

APPENDICES.

TABLE I.

Showing from the Challenger Observations the Deviations each Two Hours from the Mean Daily Temperature of the Surface of the Sea, 1872–1876.

N.B.—The Heavy Figures show a Temperature above the Mean, the Italic Figures below it.

A Minus before Latitudes signifies Latitude South, and before Longitudes it signifies Longitude West.

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M. T.
1872.	° ′	° ′													°
December 22–29.........	48 4	−9 0	*·2*	*·2*	*·3*	*·0*	**·3**	**·3**	**·1**	**·0**	**·1**	**·2**	*·3*	*·3*	52·0
December 30–Jan. 2...	41 1	−9 51	*·1*	*·1*	*·2*	*·1*	**·1**	**·3**	**·3**	**·3**	**·2**	*·1*	**·1**	**·1**	56·1
1873.															
January 13–17.........	37 8	−8 40	*·6*	*·7*	*·3*	*·3*	**·6**	**·7**	**·6**	**·5**	**·2**	**·2**	*·0*	*·4*	58·2
,, 26–31.........	35 51	−9 55	*·2*	*·5*	*·1*	**·2**	**·3**	**·6**	**·4**	**·2**	**·2**	**·0**	**·1**	*·2*	58·6
February 1–6.........	31 54	−15 47	*·2*	*·2*	*·3*	*·4*	**·2**	**·5**	**·3**	**·2**	**·2**	**·2**	*·2*	*·1*	62·3
,, 10–13.........	28 2	−17 2	*·6*	*·6*	*·5*	*·1*	**·5**	**·9**	**1·0**	**·5**	**·5**	*·3*	*·5*	*·7*	63·8
,, 15–21.........	25 47	−20 3	*·3*	*·5*	*·4*	**·1**	**·7**	**·6**	**·6**	**·4**	**·1**	*·1*	*·4*	*·3*	65·3
,, 22–28.........	23 26	−32 32	*·3*	*·5*	*·5*	*·3*	**·4**	**·6**	**·4**	**·4**	**·4**	*·0*	*·0*	*·2*	68·3
March 1–5.........	21 58	−43 28	*·5*	*·5*	*·5*	**·1**	**·5**	**·3**	**·2**	**·2**	**·2**	**·3**	*·3*	*·3*	71·7
,, 5–10.........	20 19	−52 7	*·4*	*·3*	*·2*	**·4**	**·3**	**·3**	**·3**	**·3**	**·1**	**·1**	*·4*	*·3*	73·4
,, 11–15.........	18 53	−61 1	*·2*	*·3*	*·4*	*·3*	**·1**	**·3**	**·5**	**·4**	**·1**	**·2**	**·1**	*·1*	75·5
,, 25–31.........	23 4	−65 3	*·0*	*·2*	*·2*	*·2*	**·2**	**·3**	**·3**	**·2**	**·2**	**·1**	*·0*	*·1*	74·7
April 1–4.........	25 56	−65 6	*·4*	*·4*	*·2*	**·0**	**·3**	**·1**	**·3**	**·5**	**·2**	*·0*	*·1*	*·4*	69·3
,, 21–25.........	32 28	−65 24	*·5*	*·6*	*·3*	**·3**	**·4**	**·4**	**·3**	**·2**	**·3**	*·2*	*·1*	*·3*	67·8
,, 26–30.........	35 2	−68 50	*·3*	*·4*	*·3*	**·2**	**·3**	**·3**	**·4**	**·3**	**·4**	**·2**	*·0*	*·2*	66·0
May {2–8......... 20–22.........}	40 37	−67 9	*·6*	*·5*	*·1*	*·2*	*·3*	**·0**	**1·3**	**1·2**	**·4**	**·3**	*·1*	*·4*	46·5
,, 23–30.........	35 35	−63 59	*·3*	*·4*	*·2*	**·2**	**·0**	**·2**	**·7**	**·7**	**·6**	*·2*	*·5*	*·4*	70·7
June 14–19.........	34 25	−57 23	*·1*	*·2*	*·2*	*·1*	**·0**	**·0**	**·0**	**·0**	**·3**	**·2**	*·0*	*·0*	71·7
,, 20–25.........	37 16	−53 45	*·5*	*·6*	*·5*	*·3*	**·0**	**·2**	**·8**	**·8**	**·6**	**·3**	*·3*	*·5*	70·9
,, 26–30.........	38 10	−33 14	*·2*	*·2*	*·3*	*·4*	**·0**	**·1**	**·1**	**·3**	**·5**	**·1**	*·0*	*·0*	70·1
July 1–4.........	38 14	−27 52	*·3*	*·2*	*·5*	*·3*	**·1**	**·5**	**·3**	**·2**	**·4**	**·0**	*·3*	*·2*	69·8
,, 10–15.........	35 2	−21 20	*·3*	*·5*	*·4*	*·2*	**·3**	**·5**	**·4**	**·4**	**·3**	*·2*	*·2*	*·3*	70·8
,, 18–26.........	24 6	−21 13	*·3*	*·3*	*·5*	*·2*	**·2**	**·4**	**·5**	**·6**	**·2**	*·0*	*·2*	*·2*	72·6
August 10–15.........	12 6	−20 19	*·2*	*·2*	*·0*	*·2*	**·1**	**·3**	**·3**	**·1**	**·0**	*·1*	*·1*	**·2**	78·4
,, 16–20.........	6 2	−15 9	*·2*	*·2*	*·3*	*·0*	**·0**	**·5**	**·4**	**·2**	**·1**	**·1**	*·1*	*·3*	78·6
,, 21–25.........	2 28	−19 46	*·1*	*·2*	*·2*	*·0*	**·1**	**·3**	**·4**	**·3**	**·2**	**·1**	*·0*	*·2*	77·8
,, 26–31.........	0 27	−29 15	*·3*	*·4*	*·3*	**·1**	**·3**	**·4**	**·3**	**·2**	**·1**	*·0*	*·0*	*·3*	77·6
September 3–8.........	−5 38	−33 49	*·0*	*·0*	*·0*	**·1**	**·2**	**·2**	**·2**	**·0**	**·0**	*·2*	*·2*	*·1*	77·8
,, 9–14.........	−10 36	−36 0	*·2*	*·2*	*·3*	*·3*	**·0**	**·1**	**·4**	**·3**	**·3**	*·0*	*·0*	*·1*	77·3
,, 26–30.........	−17 0	−36 34	*·2*	*·3*	*·4*	*·2*	**·1**	**·2**	**·3**	**·3**	**·1**	**·1**	*·0*	*·1*	75·8
October 1–5.........	−26 0	−32 35	*·6*	*·6*	*·3*	*·2*	**·4**	**·3**	**·5**	**·4**	**·3**	*·0*	*·2*	*·4*	68·8
,, 6–11.........	−32 32	−25 6	*·2*	*·3*	*·5*	*·2*	**·4**	**·7**	**·2**	**·2**	**·0**	*·0*	*·0*	*·1*	60·3
,, 12–16.........	−36 30	−13 53	*·4*	*·3*	*·2*	*·0*	**·3**	**·2**	**·5**	**·3**	**·4**	*·0*	*·1*	*·2*	54·0
,, 17–21.........	−37 0	−9 8	*·1*	*·3*	*·4*	*·3*	**·1**	**·2**	**·2**	**·1**	**·3**	**·2**	**·2**	*·2*	53·7
,, 22–27.........	−35 59	6 55	*·1*	*·0*	*·1*	**·5**	**·1**	*·1*	*·1*	*·1*	*·3*	*·3*	*·2*	**·2**	56·5
December 17–21.........	−37 2	20 2	*·2*	*·2*	*·1*	*·0*	**·4**	**·7**	*·3*	*·1*	*·0*	*·0*	*·0*	**·2**	66·8
,, 22–26.........	−45 15	33 45	*·3*	*·5*	*·2*	*·0*	**·7**	*·2*	*·2*	**·2**	*·1*	**·2**	*·2*	*·1*	44·5
,, 27–31.........	−46 31	44 30	*·5*	*·5*	*·4*	*·1*	**·3**	**·6**	**·8**	**·7**	**·6**	*·2*	*·1*	*·5*	41·5

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M. T.
1874.	° ′	° ′													°
February 1–6.........	–52 14	71 44	*·1*	*·1*	*·1*	*·0*	·2	·1	·2	·1	*·0*	*·0*	*·0*	*·1*	37·6
,, 7–13.........	–59 27	77 24	*·1*	*·1*	*·1*	*·0*	·2	·2	·3	·1	·1	·1	*·1*	*·2*	34·2
,, 14–18.........	–65 36	79 51	*·0*	·1	·2	*·1*	*·1*	*·0*	*·5*	*·5*	·4	·7	·1	·2	30·9
,, 19–23.........	–63 56	89 21	*·0*	·2	*·1*	*·2*	*·3*	·1	·1	·4	·0	*·3*	*·2*	*·2*	32·5
,, 24–28.........	–62 28	96 16	*·1*	*·1*	*·3*	*·1*	*·1*	·2	·2	·0	·0	·2	·1	*·0*	32·9
March 1–6.........	–54 6	109 36	*·5*	*·3*	*·1*	*·1*	·2	·2	·3	·3	·3	·1	*·2*	*·4*	38·8
,, 7–11.........	–48 21	128 2	*·2*	*·2*	*·3*	*·0*	·0	·0	·0	·4	·3	·3	·2	*·0*	49·5
,, 12–16.........	–41 33	137 13	*·3*	*·5*	*·4*	*·3*	·0	·3	·3	·5	·6	·2	*·0*	*·1*	57·2
April 1–16.........	–37 5	148 48	*·5*	*·1*	·2	·1	·0	·7	·6	*·1*	·3	·1	*·0*	*·1*	67·1
June 12–17.........	–34 16	153 32	*·0*	*·0*	*·1*	*·2*	*·2*	*·1*	*·1*	*·0*	·2	·4	·0	*·3*	66·0
,, 18–23.........	–37 20	162 25	*·1*	*·1*	·2	·1	·1	·0	·1	·0	·0	·0	·3	*·0*	60·7
,, 24–29.........	–40 44	173 46	*·1*	·1	·2	·1	·2	·2	*·4*	*·2*	*·2*	·1	·0	·2	53·6
July 8–12.........	–37 32	178 29	*·2*	*·1*	*·3*	*·6*	*·1*	·0	·4	·7	·3	·3	*·2*	*·1*	58·5
,, 13–18.........	–27 21	175 49	·1	·2	*·1*	*·0*	*·1*	*·2*	*·0*	*·1*	*·1*	*·1*	·2	·2	68·7
,, 19–24.........	Vicinity of	Tongatabu	*·1*	*·2*	*·2*	*·3*	·3	·4	·5	·3	·1	*·1*	*·2*	*·1*	74·8
August 11–16.........	–18 48	175 13	*·4*	*·4*	*·4*	*·5*	*·2*	·2	·7	·7	·5	·3	*·1*	*·3*	78·0
,, 17–22.........	–16 29	164 12	*·0*	*·1*	*·1*	*·2*	*·1*	·2	·3	·1	*·1*	*·1*	*·1*	*·1*	78·3
,, 23–39.........	–13 28	150 28	*·3*	*·4*	*·2*	·1	·3	·3	·4	·4	·1	·1	*·1*	*·3*	78·4
September 9–15.........	–8 44	137 6	*·2*	*·2*	*·3*	*·2*	·1	·2	·5	·4	·2	*·1*	*·2*	*·2*	79·1
,, 23–29.........	–5 24	132 13	*·5*	*·4*	*·6*	*·4*	·2	·4	·4	·6	·3	·1	*·2*	*·4*	82·0
October 1–4.........	Vicinity	of Banda	*·5*	*·5*	*·2*	·1	·4	·4	·2	·1	·1	*·1*	*·2*	*·3*	82·4
,, 10–14.........	–1 48	127 19	*·3*	*·3*	*·4*	*·1*	·1	·6	·5	·5	·1	*·2*	*·3*	*·3*	82·4
,, 17–23.........	3 46	124 53	*·5*	*·5*	*·4*	*·3*	·0	·4	·9	·9	·2	*·1*	*·2*	*·5*	83·7
,, 26–28.........	8 39	122 1	*·4*	*·4*	*·5*	*·4*	·0	·7	·7	·6	·3	*·0*	*·2*	*·3*	83·3
November 1–4.........	13 2	121 52	*·0*	*·1*	*·1*	·1	·3	·4	·2	·2	*·0*	*·1*	*·1*	*·1*	83·4
,, 11–15.........	17 0	118 46	·1	·1	*·1*	*·2*	·2	·2	·1	·1	·0	·1	*·0*	*·0*	80·1
1875.															
January 7–11.........	16 54	118 8	*·7*	*·3*	*·4*	*·4*	*·2*	·1	·8	1·0	·5	*·0*	*·1*	*·6*	76·2
,, 15–18.........	12 06	122 21	*·3*	*·4*	*·5*	*·5*	*·1*	·4	·6	·7	·3	*·1*	*·0*	*·5*	79·9
,, 25–30.........	8 15	122 57	*·2*	*·4*	*·4*	*·1*	·2	·3	·3	·3	·0	*·1*	*·0*	*·1*	80·7
February 6–11.........	5 30	125 23	*·2*	*·2*	*·4*	*·0*	·3	·4	·4	·4	·2	*·1*	*·0*	*·1*	81·3
,, 12–17.........	3 31	132 46	*·4*	*·5*	*·2*	·1	·3	·4	·6	·5	·3	·1	*·1*	*·3*	81·8
,, 18–23.........	0 2	138 10	*·1*	*·1*	*·1*	*·0*	·0	·3	·3	·3	·1	*·1*	*·1*	*·2*	82·2
,, 24–28.........	–2 7	142 27	*·5*	*·5*	*·5*	*·2*	·3	·5	·8	·7	·4	*·0*	*·2*	*·4*	83·4
March 1–3.........	–2 2	145 23	*·1*	*·1*	*·3*	*·2*	·3	·1	·2	·3	·3	·1	*·1*	*·1*	83·2
,, 11–15.........	0 31	147 37	*·2*	*·3*	*·2*	*·1*	·0	·3	·4	·3	·3	·2	*·0*	*·0*	83·3
,, 16–20.........	4 26	145 30	*·1*	*·3*	*·4*	*·2*	*·2*	·1	·3	·3	·2	·2	*·1*	*·1*	82·7
,, 21–25.........	11 22	143 17	*·1*	*·1*	*·1*	*·1*	·1	·1	·2	·3	·1	*·0*	*·0*	*·1*	80·1
,, 26–31.........	18 53	141 12	*·3*	*·5*	*·5*	*·4*	*·2*	·1	·8	·5	·5	·1	*·1*	*·5*	79·2
April 1–5.........	24 20	138 43	*·3*	*·2*	*·1*	·2	·0	·0	·9	·8	·5	*·0*	*·0*	*·3*	73·0
,, 6–10.........	29 56	137 40	*·7*	*·7*	*·0*	·3	·5	·6	·3	·7	·7	*·0*	*·5*	*·7*	67·9
May {12–15......... 25–26.........}	34 15	137 2	·3	·0	·0	*·3*	*·8*	*·5*	*·5*	*·2*	*·2*	·4	·4	·5	65·3
June 2–5.........	34 2	137 2	*·1*	*·1*	*·3*	*·2*	·1	·2	·2	·0	·2	·0	·3	·1	68·6
,, 16–21.........	35 14	147 16	·2	·4	·1	·0	*·3*	*·1*	·1	*·1*	*·2*	*·1*	·2	·2	69·8
,, 22–26.........	35 29	161 19	*·3*	*·3*	*·4*	*·3*	*·1*	·0	·4	·6	·5	·1	*·0*	*·2*	68·9
,, 27–30.........	35 44	171 8	*·4*	*·5*	*·2*	*·3*	*·2*	·5	·9	·7	·2	*·3*	*·4*	*·2*	69·5
July 1–5.........	36 30	179 27	*·4*	*·7*	*·4*	*·4*	*·1*	·1	·5	·4	·3	·2	·1	*·1*	72·1
,, 6–10.........	37 51	–169 19	*·3*	*·5*	*·2*	*·1*	*·1*	·3	·5	·6	·3	·2	*·1*	*·2*	64·5
,, 11–16.........	37 41	–157 47	*·3*	*·4*	*·3*	*·2*	·0	·1	·5	·4	·5	·2	*·3*	*·3*	67·4
,, 17–21.........	32 43	–154 43	*·3*	*·6*	*·6*	*·6*	·1	·5	·7	·5	·6	·1	*·1*	*·4*	73.8
,, 22–27.........	25 21	–155 40	*·2*	*·3*	*·2*	*·2*	·2	·4	·2	·1	·3	·1	*·1*	*·0*	76·1
August 11–14.........	20 28	–156 30	*·0*	*·2*	*·1*	·1	·3	·2	·1	*·1*	*.1*	*·2*	*·0*	*·1*	77·9
,, 20–25.........	15 24	–152 53	*·4*	*·5*	*·2*	*·1*	·1	·4	·4	·4	·4	·1	*·2*	*·3*	77·7
,, 26–31.........	9 8	–150 34	*·3*	*·4*	*·4*	*·1*	·3	·5	·8	·6	·2	*·1*	*·4*	*·4*	80·1
September 1–6.........	3 15	–149 58	*·4*	*·4*	*·2*	*·0*	·2	·3	·5	·3	·0	*·1*	*·2*	*·4*	79·3
,, 7–11.........	–5 40	–152 32	*·3*	*·3*	*·2*	*·0*	·0	·2	·4	·4	·3	*·1*	*·1*	*·1*	79·3
,, 12–18.........	–13 17	–150 4	*·2*	*·3*	*·3*	*·3*	*·1*	·3	·7	·6	·2	·1	*·1*	*·1*	79·3
October 3–8.........	–21 20	–149 40	·2	·2	·2	·1	*·0*	*2*	*·2*	*·3*	*·1*	·0	·0	·1	74·9
,, 9–13.........	–28 34	–141 39	*·2*	*·5*	*·3*	*·3*	·1	·4	·3	·3	·3	·2	·2	·1	67·3

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M. T.
1875.	° ′	° ′													°
October 14–19.........	−34 20	−133 50	*·3*	*·4*	*·4*	*·3*	*·0*	·2	·5	·6	·0	·1	*·0*	*·0*	60·9
,, 20–25.........	−39 34	−130 6	·1	*·0*	*·1*	*·2*	*·2*	·1	·2	·3	·2	·0	*·0*	*·1*	54·4
,, 26–31.........	−38 56	−114 38	*·0*	*·0*	*·1*	*·2*	·1	·2	·2	·1	·1	*·1*	*·2*	*·2*	53·5
November 1–6.........	−38 43	−98 16	*·2*	*·2*	*·2*	*·4*	*·3*	·3	·7	·6	·4	·1	*·1*	*·0*	56·6
,, 7–12.........	−37 31	−86 55	*·1*	*·3*	*·4*	*·4*	*·0*	·3	·7	·7	·6	*·0*	*·2*	*·2*	58·2
,, 13–18.........	Vicinity of Juan Fernandez		*·2*	*·2*	*·1*	*·0*	*·0*	·1	·2	·1	*·1*	*·1*	*·1*	*·1*	58·5
December 12–17.........	−33 14	−75 53	*·1*	*·3*	*·4*	*·5*	*·2*	·3	·6	·5	·2	·1	*·0*	*·1*	62·5
,, 18–24.........	−37 4	−83 17	*·2*	*·4*	*·5*	*·4*	*·2*	·1	·3	·3	·4	·2	·1	*·0*	59·4
,, 25–31.........	−43 10	−82 35	*·2*	*·3*	*·4*	*·2*	·1	·2	·4	·4	·2	*·0*	*·1*	*·2*	55·2
1876.															
January 20–23.........	−51 41	−63 36	*·3*	*·6*	*·6*	*·2*	·2	·6	·6	·5	·5	·1	*·2*	*·3*	49·0
February 6–10.........	−48 47	−56 18	*·1*	*·3*	*·5*	*·2*	·1	·0	·2	·5	·6	·2	·3	·2	48·7
,, 6–15.........	−43 58	−55 38	*·6*	*·7*	*·4*	*·1*	·2	·4	·3	·4	·5	·1	*·2*	*·5*	56·0
,, 25–29.........	−35 31	−52 9	*·9*	*·7*	*·5*	*·5*	·3	·7	·7	·8	·7	·1	*·4*	*·7*	71·9
March 1–6.........	−36 59	−43 46	*·5*	*·5*	*·2*	·1	·4	·7	·6	·1	·0	*·2*	*·4*	*·6*	69·0
,, 7–11.........	−37 19	−30 38	*·3*	*·3*	*·0*	*·0*	·1	·0	·1	·1	·0	·0	·0	*·1*	64·4
,, 12–16.........	−35 9	−18 33	*·5*	*·4*	*·1*	*·0*	·2	·4	·7	·8	·3	*·1*	*·5*	*·5*	69·1
,, 17–21.........	−25 29	−13 27	*·4*	*·2*	*·3*	*·1*	·0	·2	·3	·3	·2	·1	*·0*	*·2*	76·3
,, 22–27.........	−13 46	−13 59	*·1*	*·4*	*·3*	*·1*	*·0*	·2	·3	·3	·1	·1	*·0*	*·0*	77·9
April 3–7.........	−4 19	−14 32	*·4*	*·5*	*·4*	*·1*	·1	·1	·2	·3	·3	·0	·0	*·1*	81·9
,, 8–12.........	5 18	−15 5	*·2*	*·3*	*·2*	*·3*	*·2*	·3	·5	·6	·2	*·0*	*·1*	*·2*	82·9
,, 13–18.........	13 20	−21 41	*·3*	*·5*	*·3*	*·1*	·2	·3	·3	·4	·0	*·1*	*·1*	*·2*	73·7
,, 26–30.........	17 56	−28 9	*·4*	*·5*	*·4*	*·5*	*·3*	·3	·6	·8	·6	·4	*·2*	*·3*	73·2
May 1–6.........	27 4	−34 5	*·1*	*·3*	*·3*	*·3*	*·1*	·1	·4	·5	·2	*·1*	*·1*	*·2*	70·6
,, 7–12.........	38 56	−32 17	*·3*	*·2*	*·2*	*·1*	·1	·1	·2	·2	*·0*	*·1*	*·0*	*·1*	63·2
,, 13–17.........	42 27	−22 45	·2	*·1*	·0	*·1*	·1	·1	·0	·0	*·1*	·0	*·1*	*·1*	58·1
,, 17–22.........	42 59	−11 1	*·3*	*·5*	*·4*	*·2*	·1	·4	·7	·7	·1	*·0*	*·2*	*·2*	56·5

TABLE II.

Showing from the Challenger Observations the Deviations each Two Hours from the Mean Daily Temperature of the Air, 1872–1876.

N.B.—The Heavy Figures show a Temperature above the Mean, the Italic Figures below it.

A Minus before Latitudes signifies Latitude South, and before Longitudes it signifies Longitude West.

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M. T.
1872.	° ′	° ′													°
December 11–21.........	Ports	mouth	*·7*	*·4*	*·5*	*·7*	*·3*	**·8**	**1·4**	**1·7**	**·2**	*·3*	*·4*	*·6*	44·1
,, 22–29.........	48 3	–8 49	*·1*	*·1*	*·3*	*·0*	**·1**	**·2**	**·3**	**·4**	*·1*	*·1*	*·2*	**·1**	52·1
1873.															
January 4–12.........	Lis	bon	*1·2*	*1·6*	*1·2*	*1·2*	*·4*	**·5**	**2·3**	**1·8**	**·6**	**·4**	**·3**	*·8*	55·2
,, 13–17.........	37 8	–8 40	*·9*	*·7*	*·9*	*1·0*	*·8*	**·3**	**1·7**	**1·0**	**·6**	**·6**	**·2**	*·3*	57·7
,, 18–26.........	Gib	raltar	*1·3*	*1·7*	*1·8*	*1·4*	**·7**	**1·2**	**2·3**	**1·9**	**·8**	*·0*	*·3*	*1·0*	55·0
,, 27–31.........	35 51	–9 45	*·9*	*1·3*	*1·5*	*·5*	**·3**	**1·6**	**1·5**	**1·4**	**·7**	*·1*	*·5*	*·6*	57·0
February 1–6.........	Near	Madeira	*2·0*	*2·2*	*2·2*	**·1**	**·7**	**1·8**	**2·9**	**2·3**	**1·0**	*·4*	*1·3*	*1·4*	61·5
,, 7–14.........	Tener	ife	*1·4*	*2·3*	*2·1*	*1·5*	*·1*	**2·0**	**3·0**	**2·2**	**1·2**	**·1**	*·6*	*1·0*	61·7
,, 15–21.........	27 46	–20 3	*1·0*	*1·2*	*1·5*	*·0*	**·6**	**1·3**	**1·5**	**1·0**	**·4**	*·2*	*·6*	*·6*	64·7
,, 22–28.........	23 30	–32 32	*1·2*	*1·4*	*1·3*	*·2*	**·3**	**2·3**	**1·8**	**1·8**	**·1**	*·1*	*·7*	*·9*	68·6
March 1–10.........	20 34	–47 22	*1·5*	*1·5*	*1·7*	*·7*	**·6**	**1·2**	**1·7**	**1·2**	**·1**	*·3*	*·8*	*1·1*	72·8
,, 11–16.........	18 45	–61 41	*1·0*	*1·1*	*1·1*	*·4*	**1·0**	**1·8**	**1·6**	**·8**	**·4**	*·6*	*·7*	*·8*	75·2
,, 17–24.........	St.	Thomas	*1·2*	*1·2*	*1·5*	*·6*	**·8**	**1·9**	**1·7**	**1·4**	**·4**	*·4*	*·9*	*·9*	73·7
,, 25–31.........	23 4	–65 14	*1·7*	*1·8*	*1·9*	*·3*	**1·7**	**2·3**	**2·9**	**2·2**	**·7**	*·1*	*1·1*	*1·5*	75·5
April 1–4.........	30 43	–64 55	*1·5*	*1·6*	*1·0*	*·2*	**·7**	**1·3**	**2·0**	**1·6**	**1·3**	**·2**	*1·3*	*1·3*	69·7
,, 5–20.........	Ber	muda	*1·3*	*1·4*	*1·8*	*·5*	**·8**	**1·7**	**1·7**	**1·6**	**·5**	*·3*	*·5*	*1·2*	67·5
,, 21–30.........	33 39	–67 24	*·5*	*1·4*	*1·1*	**·1**	**·7**	**1·2**	**1·7**	**·9**	**·5**	*·4*	*·6*	*·6*	65·3
May 1–8.........	39 30	–68 59	*1·5*	*1·4*	*1·1*	**·2**	**·6**	**·8**	**2·0**	**2·2**	**·0**	*·9*	*1·1*	*1·1*	49·2
,, 9–19.........	Hali	fax	*3·4*	*3·9*	*2·6*	*·1*	**2·2**	**3·5**	**3·5**	**3·5**	**3·1**	*·2*	*1·4*	*2·5*	46·6
,, 23–30.........	35 33	–63 59	*1·0*	*1·2*	*·9*	*·2*	**·3**	**1·0**	**1·4**	**1·5**	**1·0**	*·3*	*·4*	*·8*	71·8
June 1–12.........	Ber	muda	*1·9*	*1·9*	*1·6*	*·7*	**1·2**	**2·0**	**2·1**	**2·0**	**1·4**	*·2*	*1·1*	*1·5*	72·4
,, 13–22.........	34 48	–34 25	*1·3*	*1·3*	*·8*	*·5*	**·9**	**1·1**	**1·8**	**1·6**	**·9**	*·3*	*·5*	*·9*	73·4
,, 23–30.........	38 15	–35 43	*·9*	*·9*	*1·2*	*·6*	**·8**	**1·4**	**1·4**	**1·3**	**·7**	*·4*	*·7*	*1·0*	70·6
July 1–9.........	Near St.	Michael's	*1·2*	*2·2*	*2·0*	**·1**	**1·3**	**1·6**	**1·7**	**2·0**	**1·1**	*·1*	*1·2*	*1·3*	69·2
,, 10–15.........	35 2	–21 20	*1·5*	*2·0*	*1·9*	*·6*	**·9**	**2·2**	**2·7**	**1·9**	**1·8**	*·6*	*1·2*	*1·4*	71·2
,, 16–18.........	Mad	eira	*2·1*	*2·9*	*2·4*	*·1*	**·9**	**1·5**	**3·0**	**3·2**	**2·1**	**·2**	*1·4*	*1·7*	70·8
,, 19–26.........	23 16	–21 26	*·9*	*1·4*	*1·2*	*·4*	**·1**	**2·0**	**2·1**	**2·0**	**·2**	*·3*	*·7*	*·8*	73·0
July 28–Aug. 4.........	St.	Vincent	*1·4*	*1·9*	*2·2*	*·8*	**1·3**	**2·6**	**2·4**	**2·0**	**·2**	*·5*	*·7*	*1·0*	76·6
August 5–9.........	Porto	Praya	*1·5*	*1·8*	*2·5*	*·7*	**1·8**	**2·2**	**1·9**	**1·9**	**·6**	*·2*	*·5*	*·9*	78·0
,, 10–15.........	11 6	–20 29	*1·0*	*1·0*	*·7*	*·5*	**·2**	**1·2**	**·9**	**·7**	**·2**	*·0*	*·1*	*·4*	77·6
,, 16–20.........	6 2	–15 9	*1·3*	*1·3*	*1·2*	*·8*	**·7**	**1·8**	**1·6**	**1·5**	**·2**	*·2*	*·7*	*·8*	77·8
,, 21–31.........	1 14	–24 23	*1·2*	*1·3*	*1·7*	*·1*	**1·3**	**1·6**	**1·2**	**1·0**	**·3**	*·4*	*·5*	*·7*	77·2
September 1–8.........	–4 58	–33 34	*·8*	*1·3*	*1·1*	**·1**	**1·4**	**1·1**	**1·0**	**1·0**	**·2**	*·5*	*·3*	*·9*	76·9
,, 9–14.........	–10 36	–36 0	*·9*	*1·4*	*1·5*	**·4**	**1·3**	**1·7**	**1·1**	**·4**	**·0**	*·1*	*·6*	*·7*	76·5
,, 15–25.........	Ba	hia	*1·3*	*1·3*	*1·5*	*·1*	**·7**	**1·2**	**1·5**	**1·7**	**·6**	*·2*	*·6*	*1·0*	75·3
,, 26–30.........	–17 0	–36 34	*1·2*	*1·7*	*1·7*	*·3*	**1·2**	**1·9**	**1·6**	**·9**	**·5**	**·3**	*1·3*	*1·3*	75·7
October 1–7.........	–26 58	–31 13	*2·0*	*2·3*	*1·4*	*·7*	**1·1**	**2·2**	**2·5**	**2·2**	*·0*	*·4*	*1·3*	*1·6*	68·7
,, 8–14.........	–35 0	–20 6	*·6*	*·7*	*·7*	*·3*	**·5**	**1·1**	**·6**	**·6**	*·1*	*·3*	*·4*	*·4*	53·5
,, 15–22.........	–36 46	–8 35	*1·0*	*·7*	*·6*	*·2*	**·3**	**·9**	**1·5**	**1·4**	**·3**	*·5*	*·4*	*·8*	51·4
,, 23–27.........	–35 59	8 29	*·4*	*1·3*	*·5*	**·3**	**·3**	**·9**	**1·1**	**·7**	**·1**	*·2*	*·4*	*·3*	53·6

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M.T.
1873.	° ′	° ′													°
November 1–30………	Simon's	Bay	*2·8*	*3·4*	*2·4*	*·2*	1·8	3·3	4·3	4·4	·9	*1·3*	*2·1*	*2·3*	64·8
December 1–15………	Near Ta	ble Bay	*3·4*	*3·6*	*2·9*	*·9*	1·9	3·9	4·1	4·3	2·0	*·6*	*2·0*	*2·4*	64·7
,, 17–22………	—37 55	21 24	*1·2*	*1·9*	*1·1*	*·6*	·9	1·0	1·3	1·4	·4	*·3*	*1·1*	*·9*	66·2
,, 22–31………	—45 53	38 59	*1·1*	*1·4*	*1·1*	*·8*	·6	1·2	1·9	1·1	·7	*·1*	*·3*	*·6*	44·0
1874.															
January 1–6………	—47 16	56 23	*·2*	*1·0*	*·5*	*·4*	·1	·6	·9	*·1*	·3	·0	*·3*	*·1*	41·8
,, 7–31………	Kergu	elen	*2·1*	*2·0*	*1·3*	*·0*	1·0	2·3	2·7	1·9	1·1	*·2*	*1·1*	*1·7*	43·9
February 1–10………	—54 5	73 14	*·4*	*·6*	*·7*	*·2*	·2	1·1	1·0	·6	·2	*·1*	*·4*	*·2*	37·6
,, 11–28………	—62 40	85 26	*·3*	*·2*	*·2*	*·0*	·0	·4	·5	·3	·2	*·1*	*·4*	*·3*	30·9
March 1–10………	—51 54	117 47	*·6*	*·6*	*·3*	*·2*	·7	·9	·6	·5	·3	*·3*	*·3*	*·5*	43·4
,, 7–16………	—44 51	132 38	*·6*	*·6*	*·4*	*·0*	·4	·5	·8	·7	·4	*·1*	*·2*	*·5*	52·3
,, 17–31………	Melb	ourne	*2·5*	*2·8*	*3·2*	*1·5*	·8	3·1	3·5	3·5	1·5	·4	*·8*	*1·9*	63·2
April 1–6………	—37 5	148 29	*1·0*	*1·2*	*1·2*	*·6*	·1	1·4	1·3	1·0	·7	*·3*	*·6*	*·8*	64·6
,, 7–30………	Syd	ney	*2·1*	*2·7*	*3·1*	*2·4*	·8	2·8	3·3	2·9	1·3	·4	*·2*	*1·2*	66·8
May 1–31………	Syd	ney	*2·5*	*3·2*	*3·8*	*2·9*	1·0	3·1	5·2	4·5	1·6	*·1*	*1·2*	*1·9*	59·6
June 1–11………	Syd	ney	*2·7*	*3·3*	*4·3*	*3·3*	*·9*	2·6	6·6	5·7	2·7	·6	*1·3*	*2·0*	55·5
,, 12–16………	—34 6	153 8	*·1*	*·7*	*·7*	*·6*	*·5*	·1	·7	·4	·8	·8	·1	·1	59·0
,, 17–28………	—38 30	166 34	*·4*	*·7*	*·4*	*·3*	·2	·6	·8	·5	·1	*·2*	*·2*	*·3*	55·2
June 28–July 7………	Wellin	gton	*·7*	*·9*	*·9*	*·7*	*·0*	·8	1·4	1·2	·4	·3	*·2*	*·5*	49·2
July 8–12………	—37 28	—179 57	*·3*	*·7*	*·6*	*·1*	*·0*	·3	·7	·6	·5	·3	*·1*	*·1*	57·3
,, 13–17………	—28 14	176 15	*·2*	*·6*	*1·2*	*·8*	·2	·3	·7	·8	·5	·4	·2	*·1*	66·4
,, 18–24………	Near Ton	gatabu	*1·2*	*1·3*	*1·5*	*·5*	·5	1·6	1·9	1·4	·9	*·1*	*·5*	*·7*	70·1
,, 25–31………	Near L	evuka	*1·1*	*1·5*	*1·6*	*·8*	·9	2·0	2·5	1·2	*·1*	*·6*	*·6*	*·9*	74·3
August 1–11………	Nga	loa	*1·6*	*2·0*	*2·3*	*1·1*	·9	2·6	2·6	2·1	·3	*·3*	*·6*	*1·1*	76·8
,, 12–21………	—17 44	169 54	*·9*	*·7*	*·7*	*·0*	·9	·8	·8	·6	·4	*·0*	*·2*	*·5*	75·9
,, 22–31………	—13 5	150 0	*·9*	*1·0*	*1·3*	·3	1·2	1·3	1·1	·8	·1	*·5*	*·5*	*·7*	76·9
September 1–7………	Port	Albany	*·9*	*1·2*	*·7*	*·3*	1·0	1·3	·8	·7	·2	·2	*·3*	*·5*	77·3
,, 8–15………	—8 59	137 40	*1·0*	*1·0*	*·9*	·1	1·3	1·0	1·1	·6	·2	*·3*	*·3*	*·6*	78·8
,, 16–22………	Dobbo	Harb.	*1·6*	*1·8*	*1·9*	*·9*	1·4	2·2	2·5	2·4	·5	*·4*	*·7*	*1·2*	79·6
,, 23–30………	—5 4	131 55	*1·2*	*1·5*	*1·9*	*·2*	1·0	1·1	1·7	1·6	·9	·1	*·5*	*1·1*	80·8
October 1-4………	—4 9	129 17	*·8*	*1·2*	*·6*	*·0*	·3	·7	1·4	·3	·1	*·1*	*·4*	*·8*	79·2
,, 5–10………	Amb	oina	*2·3*	*2·7*	*2·3*	*·5*	1·7	3·3	3·2	2·9	·7	*·6*	*1·2*	*1·7*	78·7
,, 11–15………	—0 48	127 8	*1·5*	*1·8*	*1·2*	*·1*	1·0	2·2	1·8	·9	·2	*·2*	*1·3*	*1·4*	80·8
,, 16–20………	1 30	126 14	*1·5*	*2·5*	*1·9*	*·3*	·8	2·2	2·9	2·0	·2	*·5*	*·6*	*·9*	81·0
,, 21–25………	5 57	122 53	*2·6*	*2·5*	*3·2*	*·4*	1·9	2·2	3·0	3·0	1·4	·1	*·7*	*1·7*	81·5
,, 26–31………	10 3	122 30	*2·1*	*2·4*	*2·5*	*1·0*	·8	1·6	2·5	2·6	1·1	·4	*·7*	*1·9*	81·0
November 1-4………	13 2	121 52	*1·1*	*1·2*	*1·8*	*·7*	·1	1·3	2·0	2·6	1·1	*·1*	*·3*	*1·2*	81·2
,, 5-11………	Man	ila	*1·5*	*1·8*	*2·6*	*1·2*	·8	1·5	2·2	2·5	1·3	·2	*·3*	*·7*	78·8
,, 12–16………	18 26	117 25	*·3*	*·7*	*1·0*	*·4*	·1	·3	1·3	·8	·1	*·1*	*·2*	*·2*	76·2
,, 17–30………	Hong	Kong	*2·4*	*2·8*	*3·3*	*1·0*	2·8	3·5	4·2	3·4	·3	*·9*	*1·4*	*2·3*	65·4
December 1–31………	Hong	Kong	*2·3*	*2·7*	*3·0*	*1·7*	1·5	3·4	4·5	3·5	·6	*·6*	*1·4*	*2·1*	65·9
1875.															
January 1–6………	Hong	Kong	*3·0*	*3·9*	*5·6*	*3·5*	·3	3·7	6·4	6·5	2·0	*·0*	*1·0*	*2·0*	61·2
,, 7–10………	16 56	118 8	*1·1*	*1·3*	*1·3*	*1·0*	·0	1·0	2·3	2·1	1·2	*·0*	*·7*	*·8*	75·5
,, 12–18………	13 20	121 53	*·6*	*1·0*	*1·3*	*·8*	·9	2·6	3·4	3·6	2·4	·9	·3	*·4*	79·1
,, 19–24………	Ze	bu	*2·6*	*2·0*	*2·3*	*·6*	1·7	2·9	3·8	4·0	2·4	·8	*·5*	*1·0*	78·9
,, 25–31………	8 0	122 49	*1·4*	*1·9*	*2·1*	*1·1*	·3	1·3	1·3	1·8	1·5	·6	*·1*	*·3*	80·0
February 1–5………	Near Sam	boangan	*3·2*	*3·7*	*3·4*	*1·9*	1·3	2·7	4·2	4·0	2·8	·3	*1·3*	*1·8*	79·5
,, 6–10………	5 42	124 39	*1·4*	*1·3*	*1·9*	*·6*	1·0	1·5	2·6	1·9	·1	*·4*	*·5*	*·6*	80·7
,, 11–15………	4 0	131 18	·1	*·3*	*·6*	*·1*	·4	1·0	·9	·7	*·5*	*·5*	*·3*	*·1*	79·5
,, 16–20………	1 48	136 5	*·3*	*·5*	*·1*	·6	·6	1·1	·1	*·7*	*·4*	*·2*	*·3*	*·3*	78·9
,, 21–28………	—1 55	141 12	*·4*	*·6*	*1·1*	*·4*	*·3*	·3	1·4	1·3	·6	·2	*·1*	*·4*	80·2
March 1–10………	Near Na	res' Harb.	*·1*	*·8*	*1·1*	*·4*	*·1*	·3	1·2	·5	·2	·3	·4	*·0*	80·5
,, 11–15………	0 39	147 43	*·8*	*1·3*	*1·2*	*·6*	*·1*	1·1	1·9	1·2	·7	*·1*	*·3*	*·4*	81·7
,, 16–20………	4 26	145 27	*·7*	*1·0*	*1·4*	*·6*	·5	1·1	1·3	1·0	·5	·1	*·2*	*·4*	81·5
,, 21–25………	11 22	143 15	*·7*	*·8*	*1·3*	*·0*	·6	·5	1·2	·6	·1	*·4*	*·5*	*·8*	79·7
,, 26–31………	18 53	141 12	*·9*	*1·3*	*1·5*	·1	·6	1·4	1·8	1·6	·4	*·6*	*·7*	*·7*	78·5
April 1–6………	24 50	138 43	*1·1*	*1·2*	*1·1*	*·6*	·7	1·4	1·8	1·5	·2	*·6*	*·6*	*·9*	72·2
,, 7–11………	28 09	138 22	*·6*	*·8*	*·9*	*·3*	·3	·8	1·0	·9	·6	*·0*	*·1*	*·3*	67·7
,, 12–25………	Yoko	hama	*3·0*	*4·4*	*5·9*	*2·8*	1·0	3·2	5·3	5·1	3·1	·7	*·8*	*2·0*	57·3
April 26–May 3………	Yok	oska	*2·5*	*3·7*	*4·1*	*1·9*	·7	2·1	4·5	3·6	2·9	·6	*·6*	*1·6*	55·4

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M. T.
	° ′	° ′													°
1875.															
May 4–11………	Yokohama		3·7	4·7	4·4	1·4	2·4	4·5	4·6	3·8	2·3	·1	1·4	2·7	61·3
,, 12–15………	34 15	137 1	2·4	2·6	2·1	1·0	·9	1·1	2·2	3·4	1·7	·7	·7	1·5	64·9
,, 16–24………	Kobé		2·7	4·2	4·2	1·7	·4	3·2	4·9	4·5	3·1	·3	·9	2·1	67·6
,, 25–31………	34 35	134 15	3·4	3·9	4·0	1·7	1·0	2·1	4·1	4·8	3·7	·5	1·2	2·5	66·2
June 1–5………	34 13	136 44	·9	1·7	2·5	1·6	·2	1·1	1·5	2·4	1·8	1·0	·1	·8	68·0
,, 6–16………	Yokohama		2·4	3·1	2·9	2·0	·6	2·3	3·8	3·6	1·8	·0	·6	1·6	69·7
,, 17–24………	35 22	151 28	·2	·3	·6	·4	·1	·1	·7	·9	·6	·2	·1	·2	70·3
,, 25–30………	35 37	169 17	·5	·8	·9	·5	·0	·5	1·3	1·0	1·0	·2	·7	·5	71·2
July 1–5………	36 30	179 23	1·3	1·2	1·4	·5	·1	1·2	2·0	1·6	·9	·0	·3	·7	71·6
,, 6–11………	37 50	—168 2	1·2	1·3	·9	·2	·2	1·3	1·5	1·3	1·0	·0	·5	·7	64·9
,, 12–19………	36 23	—156 12	1·1	1·4	1·1	·2	·3	1·4	1·8	1·8	1·2	·4	·9	1·0	69·8
,, 20–27………	28 37	—155 25	1·5	1·6	1·2	·0	1·1	1·6	1·3	1·1	·9	·6	·7	1·1	75·1
July 28–Aug. 10………	Honolulu		2·1	2·5	2·9	1·3	·8	2·5	3·7	3·5	1·3	·5	1·1	1·6	77·9
August 11–19………	Near Hilo		2·2	2·7	1·9	·7	1·1	1·9	3·3	3·2	1·6	·2	1·1	1·8	76·9
,, 20–25………	15 24	—152 53	·8	1·4	1·1	·6	1·2	1·5	1·6	1·1	·1	·1	·6	·6	77·1
,, 26–31………	9 8	—150 34	·7	1·1	1·3	·1	1·2	1·2	1·2	·6	·1	·4	·4	·9	78·1
September 1–6………	3 21	—149 0	1·2	1·0	1·0	·0	1·2	1·3	1·4	1·0	·6	·4	·6	·8	78·3
,, 7–11………	—5 40	—152 32	·8	·9	1·3	1·0	·3	1·1	1·7	1·5	·3	·3	·3	·6	78·7
,, 13–18………	—13 17	—150 4	1·2	·9	1·4	·0	1·3	1·8	1·8	1·5	·4	·5	·7	·8	77·9
Sept. 19–Oct. 2………	Tahiti		3·4	3·9	4·5	·6	2·4	4·2	4·3	3·7	2·4	·0	1·7	2·6	76·7
October 3–11………	—23 21	—147 29	·7	1·4	1·8	·9	·9	1·0	1·6	·9	·4	·1	·0	·4	70·9
,, 12–22………	—35 3	—134 36	1·3	1·5	1·4	·8	·2	1·4	2·0	1·5	1·5	·3	·6	1·0	59·3
,, 23–31………	—38 7	—119 5	1·0	1·4	1·0	·8	·3	1·0	1·4	1·3	1·4	·3	·4	·3	51·2
November 1–8………	—38 32	—96 50	1·6	2·2	1·8	·5	·9	2·1	2·8	2·2	1·2	·4	·9	1·2	58·2
,, 9–13………	—36 47	—83 20	1·4	1·6	1·6	1·0	1·0	1·7	2·8	2·0	·4	·7	·7	1·2	57·9
,, 14–18………	Near Juan Fernandez		1·0	1·0	·7	·6	·1	1·6	1·3	·8	·3	·3	·5	·8	59·7
,, 19–30………	Valparaiso		4·3	4·7	3·9	1·3	2·6	4·3	7·4	5·0	3·2	·2	2·1	3·6	63·5
December 1–11………	Valparaiso		4·9	5·5	5·0	1·2	1·9	3·8	5·8	5·6	4·8	·1	2·4	3·7	63·2
,, 12–16………	—33 8	—75 24	2·4	1·9	1·6	·7	1·6	1·9	3·4	2·4	·7	1·0	1·2	1·4	61·3
,, 17–21………	—35 22	—81 21	1·3	1·5	1·3	·8	·2	1·6	2·1	1·3	1·0	·3	·6	1·0	59·0
,, 20–26………	—38 45	—85 35	1·0	1·7	1·1	·3	1·0	1·8	1·7	1·2	·1	·5	1·1	1·1	55·9
,, 27–31………	—44 5	—80 10	·8	1·0	1·2	·5	·0	·7	1·3	1·3	·9	·0	·5	·7	53·4
1876.															
January 1–6………	—49 0	—74 30	2·9	4·0	3·3	·9	1·4	3·1	4·1	3·0	2·2	·4	1·6	2·6	54·4
,, 6–12………	—51 28	—74 4	2·0	1·8	1·2	·2	·2	1·8	2·6	2·5	1·2	·2	·3	·8	49·0
,, 13–19………	Near Sandy Point		2·1	2·6	2·0	·6	·8	1·6	2·8	2·2	2·3	·8	1·0	1·6	49·3
,, 20–31………	Near Port Stanley		2·3	2·3	2·1	·3	1·8	1·9	2·3	2·1	1·8	·5	1·7	2·4	49·1
February 1–7………	Near Port Louis		2·2	2·5	1·1	·3	·9	2·0	2·0	2·2	2·0	·1	1·1	1·9	47·8
,, 8–15………	—42 15	—55 18	2·2	1·5	1·3	·1	1·4	1·5	1·6	1·6	1·6	·1	1·2	1·6	56·4
,, 16–24………	Monte Video		3·7	4·3	5·2	2·4	3·0	3·5	5·4	4·8	2·6	·1	1·6	2·5	71·0
,, 25–29………	—35 21	—52 9	·8	·8	·8	·4	·2	·7	·7	1·1	·9	·0	·5	·7	71·3
March 1–6………	—36 59	—43 46	1·3	1·6	1·3	·6	1·1	2·2	1·6	1·4	·8	·5	1·0	·8	68·4
,, 7–11………	—37 23	—30 32	·9	·9	·6	·0	·3	1·0	1·4	1·5	·2	·3	·7	·5	64·4
,, 12–17………	—34 2	—17 40	·8	1·0	·8	·3	·7	1·5	1·7	·9	·2	·5	·6	·6	70·6
,, 18–22………	—23 19	—13 45	·9	·6	·3	·4	1·0	·6	·6	·5	·4	·6	·4	·5	74·7
,, 23–27………	—12 35	—13 54	·7	·5	·6	·1	·3	·8	·9	·9	·5	·2	·4	·4	77·5
March 28–Apr. 2………	Ascension		2·2	2·5	2·5	·2	2·1	2·7	2·3	2·0	·9	·3	1·0	1·4	80·5
April 3–7………	—4 21	—14 30	·6	·9	1·3	·0	·4	·8	·7	1·1	·5	·2	·3	·3	81·2
,, 8–12………	5 18	—15 5	1·1	1·4	1·4	·5	1·4	1·6	1·9	1·7	·8	·0	1·0	·7	81·1
,, 13–18………	13 20	—21 34	1·2	1·5	1·8	·0	1·4	1·4	1·7	1·3	·4	·4	·5	·9	72·0
,, 19–25………	Porto Grande		2·0	2·4	2·3	1·1	2·5	2·6	2·3	1·6	·2	1·0	1·4	2·0	71·3
,, 26–30………	17 56	—28 10	1·0	1·2	1·2	·5	·3	1·5	2·1	1·3	·4	·3	·8	·8	71·9
May 1–6………	27 4	—34 5	1·0	1·1	1·0	·2	·5	1·0	1·8	1·5	·4	·2	·5	·8	69·6
,, 7–12………	38 56	—32 7	·9	1·3	·8	·6	1·1	1·0	1·1	1·0	·2	·5	·7	·7	60·5
,, 13–17………	42 27	—22 44	·9	1·1	1·0	·5	·3	1·0	1·8	1·3	·5	·3	·5	1·1	56·9
,, 18–22………	42 59	—11 5	2·6	2·4	2·2	·6	·5	1·6	3·5	3·3	2·0	·5	1·4	2·0	57·3
,, 23–27………	50 8	—2 15	·9	1·3	1·2	1·4	1·0	·6	2·2	1·5	1·7	·7	·1	1·1	52·0

TABLE III.

Showing from the Challenger Observations the Deviations each Two Hours from the Mean Daily Atmospheric Pressure, 1872–1876.

N.B.—The Heavy Figures show a Pressure above the Mean, the Italic Figures below it, the Differences being expressed in Thousandths of an Inch.

A Minus before Latitudes signifies Latitude South, and before Longitudes it signifies Longitude West.

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M.P.
1872.	° ′	° ′													Inches.
December 12–21.........	Portsmouth		*4*	*8*	*2*	**5**	**5**	*1*	*4*	*1*	**3**	**4**	**7**	*10*	29·672
,, 22–31.........	48 3	−8 49	*12*	*20*	*26*	*4*	**9**	*6*	*2*	**1**	**14**	**19**	**14**	**10**	·523
1873.															
January 4–12.........	Lisbon		**1**	*5*	*10*	**4**	**21**	**11**	*10*	*9*	*13*	**1**	**5**	**2**	30·135
,, 13–17.........	37 8	−8 40	*8*	*17*	*19*	**21**	**48**	**20**	*11*	*26*	*15*	*0*	**12**	*8*	·299
,, 18–25.........	Gibraltar		*5*	*6*	*10*	**16**	**24**	**19**	*21*	*22*	**1**	**4**	**2**	*4*	·183
,, 27–31.........	35 51	−9 55	*8*	*20*	*3*	**6**	**25**	**5**	*1*	*7*	*13*	**3**	**25**	**2**	29·974
February 1–6.........	Near Madeira		*2*	*15*	*17*	**2**	**32**	**12**	*7*	*28*	*21*	**20**	**13**	**11**	30·319
,, 7–14.........	Near Tenerife		*9*	*14*	*16*	**3**	**12**	**5**	*4*	*6*	*4*	**5**	**13**	**3**	·042
,, 15–21.........	27 46	−20 3	*13*	*19*	*2*	**12**	**26**	**11**	*25*	*22*	*6*	**12**	**21**	**10**	·156
,, 22–28.........	23 30	−32 32	*10*	*25*	*10*	**10**	**16**	**4**	*2*	*5*	*8*	**6**	**11**	**12**	·192
March 1–10.........	20 34	−47 22	*3*	*16*	*10*	**7**	**12**	**0**	*22*	*31*	*2*	**12**	**25**	**20**	·180
,, 11–16.........	18 25	−61 41	*18*	*32*	*26*	**17**	**45**	**36**	**1**	*19*	*12*	**5**	**9**	**1**	·082
,, 17–24.........	St. Thomas		*7*	*20*	*11*	**11**	**24**	**8**	*8*	*29*	*12*	**11**	**21**	**2**	·149
,, 25–31.........	23 4	−65 14	*19*	*36*	*9*	**21**	**26**	**25**	*6*	*12*	*14*	**3**	**5**	**4**	·181
April 1–4.........	30 43	−64 55	*6*	*8*	*8*	**8**	**25**	**19**	*6*	*10*	*16*	**1**	**3**	**1**	·190
,, 5–20.........	Bermuda		*8*	*14*	*7*	**5**	**18**	**14**	**2**	*13*	*7*	*1*	**6**	**3**	·028
,, 21–30.........	33 39	−67 24	*23*	*37*	*23*	*11*	**5**	**11**	**16**	**9**	**8**	**23**	**18**	**6**	29·939
May 1–8.........	39 30	−68 59	*14*	*18*	*3*	**20**	**23**	**5**	*4*	*8*	*1*	**2**	**7**	*4*	30·106
,, 9–19.........	Halifax		**4**	**7**	**4**	*7*	*7*	*6*	*6*	*14*	*14*	**1**	**21**	**18**	29·818
,, 23–30.........	35 33	−63 59	*9*	*13*	**0**	**14**	**16**	**14**	*8*	*9*	*6*	*5*	**2**	**2**	30·120
June 1–12.........	Bermuda		*5*	*12*	*1*	**6**	**11**	**12**	**6**	*6*	*10*	*9*	**0**	**2**	·116
,, 13–22.........	34 48	−54 25	*12*	*14*	*8*	*3*	**8**	**15**	**15**	*7*	*0*	**5**	**8**	**8**	·129
,, 23–30.........	38 15	−35 43	*12*	*18*	*7*	**7**	**11**	**7**	*6*	*9*	*8*	**2**	**12**	**2**	·289
July 1–9.........	Near St. Michael's		*0*	*10*	*2*	**10**	**10**	**2**	*5*	*10*	*11*	*1*	**10**	**13**	·230
,, 10–15.........	35 2	−21 10	*14*	*20*	*9*	**7**	**17**	**14**	**2**	*16*	*11*	**9**	**14**	**3**	·246
,, 16–18.........	Madeira		*13*	*17*	*12*	**2**	**23**	**18**	**5**	**2**	*4*	*3*	*2*	*5*	·233
,, 19–26.........	23 16	−21 26	*6*	*16*	*8*	**10**	**26**	**25**	**5**	*20*	*33*	*3*	**13**	**11**	29·999
July 28–Aug. 4.........	St. Vincent		*0*	*7*	**7**	**19**	**23**	**15**	*15*	*33*	*16*	*10*	**7**	**10**	·962
August 5–9.........	Porto Praya		*7*	*14*	*11*	**17**	**27**	**19**	*8*	*21*	*27*	*11*	**23**	**17**	·939
,, 10–15.........	11 6	−20 39	*18*	*19*	*19*	**20**	**38**	**14**	*21*	*28*	*18*	**2**	**27**	**24**	·978
,, 16–20.........	6 2	−15 9	*4*	*25*	*7*	**21**	**36**	**23**	*7*	*36*	*25*	**5**	**18**	**1**	30·010
,, 21–31.........	1 14	−24 23	*10*	*24*	*7*	**22**	**30**	**14**	*11*	*32*	*15*	*1*	**23**	**19**	·038
September 1–8.........	−4 58	−33 34	*9*	*20*	*10*	**17**	**33**	**24**	*11*	*33*	*17*	**6**	**19**	**7**	·035
,, 9–14.........	−10 36	−36 0	*17*	*25*	*4*	**29**	**47**	**29**	*14*	*40*	*26*	*5*	**16**	**8**	·041
,, 15–25.........	Bahia		*5*	*20*	*2*	**20**	**33**	**30**	*16*	*34*	*28*	*4*	**13**	**14**	·008
,, 26–30.........	−17 0	−36 34	*16*	*32*	*4*	**16**	**32**	**14**	*12*	*18*	*13*	**7**	**14**	**17**	·101
October 1–7.........	−26 58	−31 13	*13*	*30*	*3*	**17**	**33**	**14**	*12*	*18*	*13*	**6**	**12**	**14**	·259
,, 8–14.........	−35 0	−20 6	*12*	*21*	*12*	**8**	**25**	**4**	*0*	*13*	*6*	**10**	**12**	**4**	29·998
,, 15–22.........	−36 46	−8 35	*2*	*19*	*13*	**8**	**13**	**4**	*21*	*30*	*14*	**19**	**33**	**24**	30·257
,, 23–27.........	−35 59	8 29	*20*	*28*	*5*	*2*	**15**	**12**	*2*	*3*	*3*	**5**	**25**	**10**	·142

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day, M.P.
1873.	° ′	° ′													Inches.
November 1–3………	Simon's	Bay	3	11	1	14	16	12	12	19	9	1	16	3	30·037
December 1–16………	Table	Bay, etc.	5	19	2	1	11	11	1	8	13	4	16	7	29·940
,, 17–21………	–37 2	20 1	21	2	7	25	8	7	31	36	34	12	27	30	·804
,, 17–26………	–41 9	26 52	7	8	3	15	12	11	4	5	11	4	3	0	·782
,, 22–31………	–45 53	38 59	14	12	3	15	20	21	9	1	6	5	11	11	·997
1874.															
January 1–6………	–47 16	56 26	52	49	14	2	29	41	44	24	14	1	28	40	·506
,, 8–31………	Ker	guelen	7	6	8	10	17	6	0	2	9	14	14	14	·711
February 1-10………	–54 5	73 14	0	7	3	3	10	10	11	0	0	6	13	13	·416
,, 11–28………	–62 40	85 26	21	13	6	17	21	18	19	11	4	18	31	31	28·905
March 1–16………	–51 54	117 47	12	7	12	15	16	6	11	7	1	7	3	10	29·870
,, 7–16………	–44 51	132 38	19	25	2	18	18	9	8	9	2	10	11	7	·821
,, 17-31………	Mel	bourne	1	3	7	26	28	21	22	33	27	8	4	4	30·076
April 1–6………	–37 5	148 29	5	11	2	27	32	13	25	27	29	3	14	12	29·856
,, 7–30………	Syd	ney	2	7	6	21	29	10	17	21	21	3	7	9	30·154
May 1–31………	Syd	ney	4	3	1	22	27	8	23	29	20	2	9	10	29·989
June 1–11………	Syd	ney	2	3	2	23	39	10	35	40	21	6	12	7	30·217
,, 12–16………	–34 6	153 8	9	26	12	22	22	10	20	20	5	13	15	16	29·715
,, 17–28………	–38 30	166 34	15	25	11	17	28	14	14	11	7	2	9	5	·880
June 28–July 7………	Well	ington	8	1	3	19	34	1	26	19	10	2	8	8	30·099
July 8–12………	–37 28	–179 57	18	24	17	17	34	11	6	6	3	4	10	3	29·832
,, 13–17………	–28 14	176 15	5	18	16	18	25	21	25	17	15	6	13	3	·931
,, 18–24………	Tonga	tabu	4	21	1	30	28	2	27	38	11	17	21	7	·988
,, 25–31………	Near	Levuka	5	11	0	25	42	20	23	40	32	7	14	15	30·025
August 1–11………	Near	Ngaloa	0	9	3	24	41	14	26	36	30	4	9	12	29·986
,, 12–21………	–17 44	169 54	6	22	5	28	36	9	26	33	17	6	13	10	·986
,, 22–31………	–13 5	150 0	11	33	2	29	30	11	22	32	15	19	26	15	·944
September 1–7………	Port	Albany	6	22	5	45	46	23	31	40	32	2	13	1	·920
,, 8–15………	–8 59	137 40	8	19	10	40	47	17	27	47	37	3	14	17	·888
,, 16–22………	Dobbo	Harb.	7	10	13	41	48	14	35	52	49	9	22	18	·847
,, 23-30………	–5 4	131 55	17	24	1	40	44	14	36	49	31	3	31	24	·871
October 1–4………	–4 9	129 17	17	24	8	35	44	11	36	47	17	6	28	15	·904
,, 5–10………	Amb	oina	10	23	20	38	41	6	34	50	32	6	25	21	·889
,, 11–15………	–0 48	127 8	6	14	10	42	46	5	37	55	35	2	29	20	·852
,, 16–20………	1 30	126 14	24	27	5	30	43	10	18	30	11	6	28	3	·824
,, 21–25………	5 57	122 53	5	29	17	27	49	18	36	56	36	6	40	32	·835
,, 26–31………	10 3	122 30	7	19	5	30	43	15	39	51	30	7	24	22	·834
November 1–4………	13 2	121 52	14	21	4	40	48	26	45	49	24	3	17	14	·890
,, 5–11………	Man	ila	6	24	5	33	43	16	28	45	28	10	25	10	·829
,, 12–16………	18 26	117 25	12	23	10	31	33	16	28	30	12	14	13	9	·959
,, 17–30………	Hong	Kong	3	9	5	46	52	16	40	48	38	6	16	8	30·169
December 1–31………	Hong	Kong	4	12	3	40	53	18	32	44	30	3	7	10	·128
1875.															
January 1–6………	Hong	Kong	5	6	4	48	58	17	41	51	27	3	3	4	·196
,, 7–11………	16 56	118 8	9	16	2	34	30	5	37	42	30	11	16	20	29·959
,, 12–18………	13 20	121 53	9	18	1	41	49	23	36	50	26	2	18	9	·861
,, 19–24………	Ze	bu	4	8	4	38	40	6	33	43	17	6	8	10	·832
,, 25–31………	8 0	122 49	14	18	11	42	48	16	43	46	24	3	14	10	·872
February 1–5………	Sambo	angan	7	9	1	39	40	6	35	45	36	8	24	22	·853
,, 6–10………	5 42	124 39	5	19	3	31	26	1	27	35	11	7	18	13	·850
,, 11–15………	4 0	131 18	24	26	5	40	34	14	21	39	4	14	28	13	·794
,, 16–20………	1 48	136 5	18	26	2	35	43	18	35	43	10	12	32	21	·835
,, 21–28………	–1 55	141 12	12	24	12	47	45	13	34	53	28	1	25	12	·840
March 1–10………	Near Na	res' Harb.	20	32	2	41	49	18	28	40	22	5	21	14	·832
,, 11–15………	0 39	147 43	27	34	3	40	33	2	25	43	8	8	34	21	·772
,, 16–20………	4 26	145 27	25	35	1	36	41	22	27	46	10	11	39	23	·848
,, 21–25………	11 22	143 15	20	20	12	35	40	16	36	49	16	1	20	23	·888
,, 26–31………	18 53	141 12	12	21	9	31	35	10	30	43	12	4	21	11	·955
April 1–6………	24 50	138 43	19	26	10	20	33	10	16	30	9	2	14	6	30·062
,, 7–11………	31 28	138 2	4	19	6	14	27	14	2	16	12	10	4	9	29·941
,, 12–25………	Yoko	hama	1	2	23	39	28	10	21	45	38	14	5	11	·865
April 26–May 3………	Yok	oska	10	6	0	20	35	22	7	23	30	13	4	12	·906

	Lat.	Long.	2 A.M.	4 A.M.	6 A.M.	8 A.M.	10 A.M.	Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	Mid-night	Day. M.P.
1875.	° ′	° ′													Inches.
May 4–11.........	Yoko	hama	1	*4*	13	23	26	24	*4*	*43*	*37*	*23*	8	17	30·076
,, 12–15.........	34 15	137 1	*13*	*30*	*25*	11	33	21	4	*24*	*24*	*6*	22	29	29·907
,, 16–24.........	Ko	bé	6	4	8	31	27	17	*15*	*30*	*32*	*24*	*9*	9	·890
,, 25–31.........	34 35	134 15	*11*	*21*	*4*	22	23	12	*8*	*18*	*13*	*5*	15	9	·869
June 1–5.........	34 13	136 44	*3*	*10*	21	29	18	13	*9*	*31*	*30*	*13*	7	4	·748
,, 6–16.........	Yoko	hama	*9*	*10*	2	23	22	15	*5*	*17*	*15*	*9*	7	0	·848
,, 17–24.........	35 22	151 28	*17*	*19*	*0*	13	27	11	*4*	*13*	*7*	*3*	12	3	·902
,, 25–30.........	35 37	169 17	*16*	*17*	1	11	16	6	*3*	*15*	*3*	4	12	*2*	30·156
July 1–5.........	36 30	179 23	*13*	*8*	12	22	22	14	*15*	*20*	*9*	*3*	2	*6*	·388
,, 6–11.........	37 50	—168 2	*14*	*21*	4	14	16	10	*3*	*12*	*8*	*4*	8	8	·050
,, 12–19.........	36 23	—156 12	*13*	*18*	1	15	17	15	5	*10*	*14*	*5*	4	*3*	·328
,, 20–27.........	28 37	—155 25	*11*	*17*	6	17	22	12	*10*	*25*	*20*	*0*	13	9	·171
July 28–Aug. 10.........	Hono	lulu	2	*8*	5	19	24	9	*19*	*38*	*28*	*5*	20	19	·056
August 11–19.........	Near	Hilo	*11*	*18*	1	23	28	15	*22*	*33*	*24*	2	17	16	·048
,, 20–25.........	15 24	—152 53	*6*	*23*	*7*	25	30	19	*22*	*32*	*13*	2	22	10	29·982
,, 26–31.........	9 8	—150 34	*20*	*33*	*2*	29	39	18	*21*	*43*	*24*	14	31	15	·941
September 1–6.........	3 21	—149 0	*0*	*10*	8	29	31	6	*40*	*50*	*25*	6	22	21	·931
,, 7–12.........	—5 40	—152 32	*18*	*32*	*0*	29	34	7	*47*	*61*	*32*	*1*	3	0	·925
,, 1–12.........	—1 10	—150 46	*9*	*21*	4	29	33	7	*44*	*56*	*29*	3	12	11	·928
,, 13–18.........	—13 17	—150 4	*15*	*31*	*11*	27	39	8	*29*	*35*	*15*	8	24	18	·957
Sept. 19–Oct. 2.........	Tah	iti	*10*	*20*	3	27	36	13	*32*	*46*	*21*	8	24	20	30·092
October 3–11.........	—23 21	—147 29	*19*	*30*	1	28	31	13	*20*	*41*	*5*	3	18	20	·010
,, 12–22.........	—35 3	—134 36	*18*	*25*	*1*	17	18	13	*7*	*18*	*4*	5	9	6	·298
,, 23–31.........	—38 7	—119 5	*10*	*20*	2	11	20	11	*8*	*19*	*11*	8	10	4	29·969
November 1–8.........	—38 32	—96 50	*6*	*20*	*5*	8	7	2	*4*	*5*	0	6	15	7	30·257
,, 9–13.........	—36 47	—83 20	*9*	*21*	*3*	17	13	10	*1*	*7*	*6*	2	13	7	·070
,, 14–18.........	Near Juan	Fernandez	*23*	*30*	*13*	*2*	13	16	13	2	*0*	13	14	*2*	29·936
,, 9–18.........	—35 21	—79 40	*11*	*26*	*8*	8	13	13	6	*3*	*3*	8	14	3	30·003
,, 19–30.........	Valpa	raiso	*23*	*30*	1	20	27	25	11	*4*	*14*	*10*	2	*7*	·022
December 1–11.........	Valpa	raiso	*17*	*27*	*7*	18	22	15	0	*11*	*15*	*0*	16	6	·008
,, 12–16.........	—33 8	—75 24	*22*	*31*	*6*	0	5	14	20	9	1	*9*	10	4	·097
,, 17–21.........	—35 22	—81 21	*25*	*27*	2	19	25	17	6	*11*	*1*	5	3	*2*	·245
,, 20–27.........	—39 15	—85 26	*18*	*30*	*0*	11	13	15	13	3	2	*1*	1	*5*	·363
,, 27–31.........	—44 5	—80 10	*26*	*17*	8	5	13	10	0	0	*6*	*5*	16	4	·170
1876.															
January 1–6.........	—49 0	—74 30	*14*	4	26	30	19	17	6	*1*	*13*	*31*	*31*	*17*	29·963
,, 6–12.........	—51 28	—74 4	5	8	17	9	*6*	*18*	*22*	*19*	*10*	2	8	7	·871
,, 1–12.........	—50 14	—74 17	*5*	6	22	15	7	*0*	*8*	*10*	*12*	*15*	*12*	*5*	·917
,, 13–19.........	Near San	dy Point	*6*	*0*	27	24	27	12	*9*	*19*	*26*	*10*	*14*	*6*	·375
,, 20–31.........	Near Port	Stanley	*2*	*8*	*3*	5	4	1	*4*	*7*	*3*	*1*	7	9	·512
February 1–7.........	Near Po	rt Louis	25	15	13	2	*11*	*11*	*25*	*28*	*24*	10	10	23	·358
,, 8–15.........	—42 15	—55 18	*14*	*2*	35	37	26	6	2	*19*	*39*	*35*	*8*	3	·730
,, 16–24.........	Monte	Video	*21*	*19*	9	35	49	30	5	*21*	*28*	*20*	*5*	*7*	·896
,, 25–29.........	—35 21	—52 9	*10*	*14*	0	11	11	12	*2*	*8*	*9*	14	13	8	·794
March 1–6.........	—36 59	—43 46	*12*	*28*	*8*	16	23	8	*12*	*11*	*8*	1	15	10	·782
,, 7–12.........	—37 8	—29 33	*22*	*31*	*6*	13	30	20	8	*8*	*4*	*3*	4	*2*	30·102
,, 12–17.........	—34 2	—17 40	*13*	*34*	*15*	8	13	16	*2*	*8*	*4*	10	20	8	29·897
,, 18–22.........	—23 19	—13 45	*19*	*25*	*21*	4	18	7	*20*	*23*	*2*	10	14	6	30·066
,, 23–27.........	—12 35	—13 54	*10*	*37*	*14*	21	23	19	*23*	*42*	*36*	2	22	16	29·921
Mar. 28–April 2.........	Ascen	sion	*8*	*21*	*6*	12	36	15	*30*	*36*	*20*	1	26	22	·900
April 3–7.........	—4 21	—14 30	*22*	*30*	*7*	30	41	18	*28*	*45*	*20*	4	33	24	·900
,, 8–12.........	5 18	—15 5	*18*	*32*	*16*	20	46	29	*17*	*36*	*19*	4	27	20	·888
,, 13–18.........	13 20	—21 34	*19*	*23*	6	21	37	17	*24*	*38*	*18*	6	23	6	·929
,, 19–25.........	Porto	Grande	*16*	*28*	2	31	37	20	*29*	*40*	*22*	4	24	21	30·014
,, 26–30.........	17 56	—28 10	*12*	*23*	2	19	26	16	*16*	*35*	*30*	*2*	26	23	·041
May 1–6.........	27 4	—34 5	*16*	*27*	*7*	18	25	18	*7*	*18*	*15*	*2*	21	10	·280
,, 7–12.........	38 56	—32 7	*14*	*23*	*4*	12	13	11	1	*12*	*4*	8	14	2	·151
,, 13–17.........	42 27	—22 44	*12*	*17*	*1*	10	12	13	11	*9*	2	11	11	5	·114
,, 18–22.........	42 59	—11 5	*9*	*21*	12	18	24	16	*10*	*10*	*16*	*5*	11	3	·201
,, 13–22.........	42 43	—16 54	*11*	*19*	5	14	18	14	0	*9*	*7*	3	11	4	·158
,, 23–27.........	50 8	—2 15	*15*	*21*	*8*	0	8	8	*4*	*8*	2	10	15	11	29·840

TABLE IV.

Showing the Mean Diurnal Variation of Atmospheric Pressure, expressed in Thousandths of an Inch, at Different Places over the Globe.

N.B.—The Light Type shows a Pressure under the Average, and the Heavy Type above it.

N. ATLANTIC.—SHIP'S LOGS.
LAT. N. 0°-5°, LONG. W. 20°-30°; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	4	3	6	2	2	1	1	2	4	1	1	2
2 ,,	18	18	19	21	17	15	12	13	15	17	17	16	16
3 ,,	28	26	29	30	27	25	19	20	24	25	28	26	26
4 ,,	29	26	30	30	30	28	21	21	24	25	30	28	27
5 ,,	21	16	22	22	23	23	15	14	17	18	22	20	19
6 ,,	5	1	6	7	9	12	4	2	4	5	7	5	6
7 ,,	14	16	12	12	8	3	10	12	12	11	11	13	11
8 ,,	29	31	28	29	25	18	23	26	26	24	27	27	26
9 ,,	36	37	38	39	35	28	32	34	35	32	36	35	35
10 ,,	34	35	38	40	37	32	34	35	35	31	36	34	35
11 ,,	22	23	28	32	30	28	28	28	26	23	26	24	27
Noon	5	6	12	15	15	17	15	13	11	8	10	7	11
1 P.M.	14	13	7	5	3	2	1	5	7	9	9	12	7
2 ,,	30	29	24	23	21	14	18	22	23	24	25	28	23
3 ,,	39	38	35	36	33	25	30	35	34	33	36	38	34
4 ,,	39	39	38	40	37	30	35	39	37	35	39	39	37
5 ,,	31	31	32	34	32	27	32	34	32	28	32	32	31
6 ,,	16	16	19	20	20	17	22	22	19	15	19	18	19
7 ,,	3	1	2	2	4	3	8	6	3	1	2	0	2
8 ,,	20	17	15	15	13	11	6	9	12	16	15	17	14
9 ,,	31	27	26	27	25	22	17	20	23	26	28	29	25
10 ,,	35	30	30	30	30	26	22	24	27	28	32	33	29
11 ,,	29	24	25	24	26	22	19	21	23	23	28	28	24
Midt.	16	11	13	11	14	12	11	11	12	11	16	16	13

N. ATLANTIC.—SHIP'S LOGS.
LAT. N. 5°-10°, LONG. W. 20°-30°; HEIGHT, 0 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	4	3	6	4	3	0	4	4	5	4	5	4
18	18	16	22	20	18	14	15	18	18	20	19	18
28	27	23	32	31	27	24	22	27	26	30	27	27
28	27	22	34	34	30	28	22	29	26	31	26	28
18	18	13	26	27	23	23	16	22	18	23	15	20
0	2	1	10	12	10	11	4	8	5	7	1	6
19	15	18	9	6	6	4	10	9	11	11	20	11
34	28	31	27	24	21	19	23	24	25	27	34	26
40	34	38	39	35	31	28	30	33	33	36	41	35
35	30	35	42	38	33	30	31	35	33	36	38	35
21	18	24	35	31	27	24	24	28	24	27	26	26
2	1	7	19	17	15	13	11	14	10	11	7	11
18	16	12	0	0	1	2	5	3	7	8	13	7
34	29	29	19	16	16	16	19	18	22	25	29	23
43	35	39	32	28	26	25	28	29	31	36	39	33
42	34	41	37	32	30	29	31	32	33	38	40	35
33	25	33	32	28	26	25	26	28	27	31	33	29
17	12	19	20	18	16	16	15	17	15	17	19	17
1	4	2	3	3	2	3	2	2	0	1	2	1
19	19	14	13	12	12	11	11	12	14	18	14	14
31	29	24	25	24	22	22	20	22	24	29	25	25
35	31	28	29	29	26	27	23	26	26	33	28	28
29	25	22	24	25	22	24	18	22	21	27	23	23
16	12	11	11	13	11	14	9	11	9	13	10	12

ASCENSION.—TWO YEARS.
LAT. S. 7° 55′, LONG. W. 14° 25′; HEIGHT, 53 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	6	3	7	6	2	1	3	2	6	3	1	1
2 ,,	6	8	10	9	10	10	13	18	9	18	11	11	11
3 ,,	13	14	14	14	18	15	20	24	19	24	15	15	17
4 ,,	12	13	13	13	17	15	20	22	19	23	15	15	16
5 ,,	4	6	7	7	11	10	16	15	11	12	7	6	9
6 ,,	9	4	4	4	1	3	7	7	1	2	6	8	2
7 ,,	18	14	17	13	10	6	4	3	12	14	20	19	13
8 ,,	26	25	23	29	22	19	19	20	24	29	31	27	25
9 ,,	28	32	32	35	32	30	31	33	34	33	36	30	32
10 ,,	24	29	27	35	32	31	34	36	33	28	29	25	30
11 ,,	15	21	22	21	23	24	29	28	23	20	19	16	22
Noon	4	8	7	5	6	9	17	18	7	4	5	5	8
1 P.M.	11	12	10	14	11	9	1	1	12	15	13	10	10
2 ,,	23	27	28	33	30	25	19	20	27	28	28	24	26
3 ,,	38	38	40	46	40	35	29	29	35	35	38	35	36
4 ,,	43	44	43	47	39	35	31	31	35	35	40	37	38
5 ,,	37	39	37	38	32	28	26	26	28	27	33	32	32
6 ,,	32	34	31	33	29	23	22	22	23	22	26	27	27
7 ,,	9	13	4	9	4	5	6	4	1	2	7	7	6
8 ,,	7	6	12	10	10	8	6	7	10	14	8	8	9
9 ,,	18	19	26	22	22	18	16	16	20	26	20	19	20
10 ,,	26	31	36	28	27	23	20	22	25	32	25	25	27
11 ,,	27	31	34	28	24	23	18	20	23	25	20	21	25
Midt.	19	22	24	20	18	16	13	14	11	10	7	9	15

ST. HELENA.—FIVE YEARS.
LAT. S. 15° 55′, LONG. W. 5° 43′; HEIGHT, 1763 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
10	4	0	5	1	1	2	0	2	8	13	12	4
22	18	14	10	10	12	10	13	16	22	26	24	16
29	27	24	22	20	23	21	22	26	33	31	31	26
26	24	26	24	21	24	25	26	30	31	28	30	26
18	20	19	20	17	22	23	25	24	24	21	19	21
1	6	8	5	7	13	15	12	12	10	3	1	7
18	12	9	11	9	1	2	0	3	8	14	18	8
29	26	26	27	25	18	15	16	17	23	23	28	23
35	36	37	38	38	33	31	31	28	32	36	34	34
35	37	39	44	41	36	35	37	32	31	36	33	36
28	31	32	33	32	28	28	28	27	28	29	28	29
18	21	18	14	15	13	12	13	11	15	16	18	15
6	4	2	4	4	5	4	4	4	2	2	4	1
10	11	18	20	21	9	20	18	19	13	10	10	15
25	25	31	33	30	26	26	27	29	26	25	25	27
34	33	36	34	31	26	24	26	29	29	31	34	30
31	33	33	30	25	22	16	20	22	24	30	32	27
22	25	25	24	18	13	9	14	14	13	21	22	18
10	14	12	12	8	4	1	2	0	1	8	9	7
5	2	3	4	6	6	9	10	14	13	8	6	7
18	14	18	16	16	14	16	18	25	24	19	17	18
26	23	27	21	19	18	20	23	27	30	27	26	24
22	23	23	20	17	14	17	21	25	23	20	21	20
7	11	13	16	9	5	12	13	15	9	6	7	10

HAVANNAH.—One Year.
Lat. N. 23° 8′, Long. W. 82° 22′; Height, 66 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	3	1	5	1	5	2	7	4	0	2	5	3
2 ,,	0	12	16	6	10	6	8	6	7	8	9	4	8
3 ,,	7	23	26	15	19	12	15	13	15	12	18	11	16
4 ,,	8	25	33	22	24	19	18	15	20	16	21	17	20
5 ,,	7	21	24	17	17	15	19	14	15	13	15	14	16
6 ,,	4	2	3	1	4	7	14	8	9	8	6	5	5
7 ,,	14	17	18	19	15	4	4	1	2	4	7	4	8
8 ,,	29	29	31	24	21	9	4	7	12	14	19	15	18
9 ,,	37	42	39	31	27	14	9	16	21	23	30	30	27
10 ,,	39	45	40	37	30	21	18	23	27	31	37	39	32
11 ,,	26	39	31	27	20	14	16	21	25	26	28	31	25
Noon	3	18	12	14	10	8	11	12	15	13	10	13	12
1 P.M.	20	11	6	2	1	2	7	4	0	2	9	7	3
2 ,,	33	27	22	14	11	7	3	10	13	20	22	21	17
3 ,,	43	38	33	26	24	15	9	17	23	26	28	29	26
4 ,,	41	40	37	35	31	25	13	24	27	28	29	31	30
5 ,,	36	32	33	35	30	27	16	25	26	26	26	30	29
6 ,,	26	22	20	26	19	17	12	18	18	17	16	20	19
7 ,,	13	6	7	17	6	7	3	10	8	8	5	12	9
8 ,,	3	6	6	6	4	3	5	1	4	2	7	1	3
9 ,,	14	12	18	6	13	15	11	11	15	14	17	13	13
10 ,,	19	22	28	18	21	22	17	20	22	19	22	20	21
11 ,,	23	16	26	24	23	27	23	19	21	19	20	20	22
Midt.	16	7	11	16	13	15	10	16	13	13	6	11	12

BATAVIA.—Sixteen Years.
Lat. S. 6° 11′, Long. E. 106° 50′; Height, 23 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	9	12	12	13	15	17	16	10	7	6	6	11
2 ,,	6	5	2	3	1	1	5	4	2	5	9	8	2
3 ,,	16	14	12	12	11	10	6	6	8	13	17	17	12
4 ,,	19	16	13	15	13	13	10	8	8	12	15	19	13
5 ,,	10	9	7	10	7	7	4	3	1	2	6	10	6
6 ,,	4	2	4	3	4	3	6	9	12	11	10	6	6
7 ,,	23	19	21	21	21	18	21	25	32	31	30	24	24
8 ,,	37	37	36	36	36	35	37	40	46	46	42	37	39
9 ,,	43	45	46	45	43	41	43	48	52	49	46	43	46
10 ,,	40	43	44	43	39	36	37	41	45	41	39	38	41
11 ,,	28	32	31	27	24	22	22	23	24	24	22	24	25
Noon	13	13	10	3	1	0	1	1	2	2	0	6	4
1 P.M.	10	12	19	23	24	23	22	26	29	30	26	16	22
2 ,,	34	35	43	47	47	45	45	49	52	52	49	40	45
3 ,,	54	54	59	63	61	57	58	63	66	65	64	58	60
4 ,,	60	62	65	64	61	58	61	65	68	67	64	60	63
5 ,,	51	55	55	50	49	47	51	55	57	52	49	48	51
6 ,,	33	36	36	31	33	31	36	38	38	30	28	29	33
7 ,,	13	15	15	11	10	11	16	17	15	7	4	6	12
8 ,,	6	4	6	10	11	9	5	5	7	12	15	13	9
9 ,,	22	21	22	27	27	26	22	23	25	27	30	28	25
10 ,,	32	33	34	34	35	33	31	33	35	37	37	36	35
11 ,,	32	32	35	35	32	32	31	34	36	34	32	32	34
Midt.	23	23	26	27	26	28	27	28	25	21	21	22	25

CHRISTIANSBORG.—Term Days.
Lat. N. 5° 24′, Long. E. 0° 40′; Height, 60 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
15	8	3	2	1	1	0	6	12	7	11	9	6
32	22	20	17	13	10	11	16	26	22	28	26	21
40	30	29	26	21	17	17	22	31	28	36	34	28
34	25	26	26	21	18	16	20	27	26	33	30	26
25	12	13	16	12	12	8	11	12	12	19	16	14
4	7	6	1	2	1	5	4	10	7	2	4	4
28	28	28	20	21	16	21	22	32	28	23	26	23
45	42	44	37	36	31	35	37	50	44	40	43	40
51	48	51	46	45	40	43	49	57	50	46	50	47
45	39	47	44	44	40	42	48	53	45	41	44	43
27	24	31	31	33	32	33	34	36	29	25	28	30
1	1	6	10	14	15	16	15	11	14	2	5	8
25	26	19	14	8	4	4	7	17	20	23	20	16
46	46	40	37	30	23	24	20	40	41	44	40	38
55	56	51	52	45	38	39	45	55	53	54	49	50
52	53	50	56	51	44	52	52	57	52	51	45	52
36	40	39	48	45	41	41	49	48	40	36	30	42
13	17	15	31	31	31	31	39	30	21	13	7	24
13	6	10	8	11	14	15	23	7	3	12	17	2
32	27	31	13	7	2	2	5	13	21	32	37	17
43	39	43	28	22	14	14	7	25	33	43	48	30
40	39	45	33	27	22	20	14	28	34	43	46	32
27	29	36	28	24	21	19	12	20	27	31	33	25
6	11	8	15	14	13	11	5	4	11	11	13	11

SINGAPORE.—Four Years.
Lat. N. 1° 17′, Long. E. 103° 51′; Height, 24 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
3	4	1	1	0	2	2	3	4	5	5	1	0
10	9	12	12	12	11	11	13	15	18	17	14	13
20	17	19	21	19	19	18	17	20	21	22	27	20
18	17	17	17	19	18	15	14	15	17	20	24	18
8	7	9	8	8	7	6	5	7	3	7	12	7
6	5	7	9	7	5	8	7	12	15	9	5	8
28	25	27	31	25	24	24	28	32	37	34	27	28
42	45	42	47	42	36	40	42	48	51	47	43	44
46	54	55	54	45	42	42	48	55	55	49	49	50
39	49	49	48	39	36	38	42	47	46	42	42	43
25	33	33	31	25	20	24	27	28	24	20	25	26
7	9	8	8	3	4	9	7	4	2	3	4	5
20	18	21	22	20	13	12	18	23	30	30	22	21
43	43	46	46	40	35	32	35	43	48	50	46	42
52	58	60	56	53	48	45	50	56	61	60	56	55
56	60	61	61	56	48	46	52	58	60	58	56	56
43	50	53	50	47	39	42	41	46	45	44	48	45
27	34	34	37	32	28	32	32	33	28	24	25	30
5	14	15	14	11	9	20	16	13	7	1	2	10
11	6	7	7	11	9	4	3	7	15	21	18	10
27	25	25	26	28	24	21	23	21	29	31	32	26
30	34	36	36	34	28	26	28	34	34	34	32	32
30	29	37	37	31	27	28	28	29	28	29	30	30
20	20	20	22	20	18	15	15	13	14	16	19	18

PEKIN.—Fifteen Years.
Lat. N. 39° 35′, Long. E. 116° 26′; Height, 123 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	11	17	16	17	12	12	5	4	3	5	9	14	10
2 ,,	8	16	14	14	7	9	0	0	0	3	7	12	8
3 ,,	4	14	10	12	5	6	3	0	2	0	3	9	5
4 ,,	3	11	9	13	8	11	1	1	0	0	0	5	5
5 ,,	3	9	10	17	18	20	5	5	8	7	1	1	9
6 ,,	4	12	21	29	32	27	12	11	17	17	6	1	16
7 ,,	14	19	33	41	42	32	19	18	24	29	17	8	25
8 ,,	27	33	43	49	49	37	25	24	32	41	28	21	34
9 ,,	36	40	50	53	50	37	29	28	38	47	36	33	40
10 ,,	38	37	46	48	46	32	26	27	38	44	37	36	38
11 ,,	29	30	34	36	33	26	20	22	27	34	25	24	28
Noon	4	7	17	17	15	15	12	13	11	15	4	1	11
1 P.M.	25	23	15	7	3	4	2	2	5	11	20	26	12
2 ,,	41	47	37	32	22	21	11	14	20	28	34	39	30
3 ,,	45	52	50	49	40	38	21	25	35	38	40	45	40
4 ,,	43	54	61	61	55	48	28	33	41	43	41	40	46
5 ,,	35	49	61	67	60	55	32	37	42	45	36	31	46
6 ,,	24	39	51	63	58	53	32	35	39	40	25	21	40
7 ,,	14	21	34	47	50	40	28	23	23	27	13	10	28
8 ,,	4	9	17	29	31	22	17	10	11	16	2	1	14
9 ,,	7	2	5	13	14	7	3	0	0	5	6	9	2
10 ,,	13	10	5	1	3	2	5	7	6	3	11	13	6
11 ,,	13	15	10	9	5	7	8	11	10	8	15	15	11
Midt.	13	18	16	19	15	13	7	7	4	5	11	14	12

ZI-KA-WEI.—One Year.
Lat. N. 31° 12′, Long. E. 121° 20′; Height, 23 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	11	16	2	0	2	2	1	5	6	1	2	2
6	2	5	4	11	10	9	9	13	2	8	2	5
13	5	6	16	16	14	14	14	18	8	11	2	11
18	13	12	14	13	13	17	15	19	12	15	8	14
17	12	10	10	6	6	10	14	14	6	12	6	10
6	6	3	1	4	5	3	2	4	1	4	1	1
8	9	9	14	17	15	16	9	8	13	12	10	12
27	22	23	24	25	21	22	16	19	27	22	20	22
37	33	28	30	32	22	24	20	28	31	33	33	29
43	36	32	32	31	22	24	23	30	29	33	39	31
29	29	26	25	27	19	19	15	23	18	21	24	23
4	10	12	14	17	12	11	8	10	2	2	3	8
20	13	10	4	0	0	2	3	6	22	24	26	11
30	31	26	20	13	9	12	14	18	32	31	37	23
34	37	36	30	25	17	20	23	28	33	32	39	30
28	33	38	34	32	25	27	23	27	32	26	31	30
19	30	34	32	33	29	30	23	22	23	18	20	26
8	20	22	25	26	25	26	16	12	18	8	7	18
4	7	12	12	15	12	10	9	3	4	2	1	6
11	4	3	0	1	1	3	6	11	9	12	12	6
14	12	12	13	8	12	12	18	21	15	17	11	14
14	11	17	22	14	19	21	21	18	17	19	12	17
8	11	15	17	9	12	20	20	15	13	17	11	14
2	14	19	13	9	8	13	9	3	12	2	4	9

HONG KONG.—Four Years.
Lat. N. 22° 18′, Long. E. 114° 10′; Height, 110 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	8	10	7	3	1	3	2	4	0	2	1	12	4
2 ,,	0	0	4	12	11	7	8	7	10	12	8	1	7
3 ,,	10	10	19	25	19	13	15	15	17	19	13	7	15
4 ,,	15	15	25	26	19	14	17	16	18	21	14	10	18
5 ,,	15	12	19	18	13	11	15	12	12	14	9	7	13
6 ,,	4	2	3	5	0	2	4	3	2	1	6	5	0
7 ,,	13	21	16	13	16	13	6	9	13	17	25	21	15
8 ,,	33	38	36	32	30	23	17	21	28	34	40	38	31
9 ,,	50	52	47	44	38	30	25	29	36	45	52	53	43
10 ,,	55	54	51	46	41	32	28	32	38	44	50	53	44
11 ,,	42	45	43	39	36	27	25	27	31	32	32	38	35
Noon	15	22	24	25	25	18	15	16	16	12	7	7	17
1 P.M.	18	8	4	2	5	2	2	1	7	12	24	27	7
2 ,,	40	34	27	17	13	13	12	17	25	32	43	47	27
3 ,,	51	50	43	35	29	26	25	29	36	42	52	57	40
4 ,,	49	53	47	44	41	37	34	38	40	42	51	54	44
5 ,,	39	46	44	44	43	39	36	39	37	35	40	43	40
6 ,,	28	36	34	34	34	32	30	32	27	26	27	29	31
7 ,,	13	24	21	20	23	21	16	19	15	21	10	11	18
8 ,,	4	5	2	2	5	4	2	1	4	10	8	4	1
9 ,,	13	6	13	15	8	8	17	17	20	20	18	14	14
10 ,,	18	13	20	24	20	23	30	28	26	22	22	19	22
11 ,,	19	15	21	23	20	22	28	26	22	19	19	17	21
Midt.	16	12	15	15	9	12	18	19	14	13	13	13	14

CALCUTTA.—Six Years.
Lat. N. 22° 33′, Long. E. 88° 21′; Height, 18 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
6	2	7	3	1	0	1	6	1	11	9	8	3
13	13	17	14	13	9	8	7	10	19	18	18	13
23	23	25	20	19	14	19	17	20	26	21	26	21
22	21	27	13	11	14	17	18	22	23	26	26	20
17	14	13	5	1	7	12	12	13	8	14	15	11
1	2	1	18	16	9	4	4	6	8	6	2	6
20	24	28	36	35	23	25	19	25	38	28	23	27
52	50	59	57	53	35	34	34	45	52	38	53	47
75	74	76	70	60	41	39	44	56	64	52	73	61
79	81	81	69	58	41	40	45	55	62	49	73	61
61	51	68	57	45	35	33	36	44	44	28	55	46
31	40	44	37	28	20	26	21	23	20	18	24	28
13	4	12	18	4	1	2	1	3	3	4	9	2
28	26	20	22	25	21	10	24	33	33	35	33	26
46	48	44	49	48	40	37	44	50	47	48	45	46
53	58	56	71	85	57	51	59	58	47	51	51	59
49	57	60	72	71	54	51	58	56	44	43	45	55
41	48	52	61	57	44	39	47	43	36	33	34	45
24	36	35	40	34	24	21	29	23	16	14	17	26
7	21	12	14	11	3	1	3	1	2	2	1	6
5	1	4	9	9	14	18	18	19	14	12	12	12
10	7	14	16	19	25	29	30	26	18	15	16	19
6	6	10	14	15	24	29	27	25	16	10	11	16
4	5	4	8	10	13	15	18	12	2	1	6	6

MADRAS.*—Five Years.
Lat. N. 13° 5′, Long. W. 80° 17′; Height, 27 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	1	3	4	7	9	9	9	6	4	2	2	4
2 ,,	16	16	15	12	8	5	3	5	8	13	19	19	12
3 ,,	30	31	28	22	18	13	11	15	18	22	31	33	23
4 ,,	33	36	31	24	21	14	12	15	19	24	33	35	25
5 ,,	26	28	21	14	12	6	7	9	9	16	24	26	17
6 ,,	12	13	6	1	3	8	6	2	4	0	9	12	2
7 ,,	9	11	20	24	25	30	24	21	26	25	16	8	20
8 ,,	37	37	44	48	44	46	39	43	49	45	39	36	42
9 ,,	60	60	62	62	55	56	49	53	62	59	57	55	57
10 ,,	64	69	67	61	54	50	48	54	60	59	58	57	59
11 ,,	52	58	55	49	41	42	37	41	46	42	42	46	46
Noon	28	33	31	28	22	23	21	22	21	15	16	2	23
1 P.M.	2	4	0	1	4	2	1	4	11	13	10	6	4
2 ,,	31	25	29	31	31	28	25	30	39	40	35	33	31
3 ,,	50	48	52	52	52	53	47	50	58	58	50	47	51
4 ,,	54	55	63	66	66	69	63	64	67	63	49	49	60
5 ,,	44	49	55	65	64	69	66	65	67	58	43	41	57
6 ,,	33	38	44	53	50	56	52	52	52	43	29	28	44
7 ,,	16	22	27	33	30	36	33	33	29	21	8	10	25
8 ,,	6	0	5	8	7	12	9	7	5	6	15	12	1
9 ,,	23	20	17	15	17	10	12	14	18	28	30	30	20
10 ,,	30	29	30	32	34	27	25	30	34	36	33	33	31
11 ,,	26	25	29	35	36	33	31	33	34	31	25	26	30
Midt.	16	16	19	22	24	25	22	25	23	19	12	14	20

DODABETTA.—Term Days.
Lat. N. 11° 32′, Long. E. 76° 50′; Height, 8640 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	19	22	27	18	7	12	0	5	10	7	10	12
2 ,,	24	39	52	43	32	21	30	12	17	28	26	22	28
3 ,,	30	37	46	47	40	41	42	22	29	38	34	30	36
4 ,,	30	37	30	49	34	39	32	32	17	32	42	40	35
5 ,,	38	33	20	47	26	35	14	24	9	28	28	24	27
6 ,,	24	21	8	33	14	21	10	6	7	0	12	10	14
7 ,,	0	11	16	13	6	9	7	14	15	14	2	2	5
8 ,,	24	33	30	1	26	13	18	18	33	32	28	20	23
9 ,,	24	60	52	22	32	27	34	32	45	40	39	41	37
10 ,,	58	53	38	41	42	47	42	45	40	46	48	50	46
11 ,,	32	51	34	35	38	35	36	47	32	24	40	42	37
Noon	18	49	18	27	34	29	28	27	14	11	19	20	25
1 P.M.	9	33	2	13	24	8	12	17	7	12	4	3	10
2 ,,	12	13	13	5	6	3	2	3	2	27	13	17	5
3 ,,	29	1	32	17	8	3	12	11	16	44	22	28	19
4 ,,	30	7	41	19	25	39	24	24	18	37	33	32	27
5 ,,	33	17	50	13	32	41	22	16	18	28	36	40	28
6 ,,	30	19	38	13	26	31	16	8	6	18	24	16	20
7 ,,	22	1	35	11	16	3	6	4	0	0	8	2	9
8 ,,	1	7	12	3	2	15	4	12	24	12	4	4	5
9 ,,	10	17	2	11	22	25	30	26	24	32	22	16	20
10 ,,	20	17	9	21	28	31	35	31	24	41	28	8	24
11 ,,	18	9	30	13	26	17	32	18	26	35	20	6	21
Midt.	0	1	2	16	0	11	2	8	14	6	12	2	2

BOMBAY.—Six Years.
Lat. N. 18° 54′, Long. E. 72° 51′; Height, 35 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	7	10	8	10	10	10	8	11	14	14	8	10
2 ,,	18	21	19	20	21	23	23	23	24	24	25	20	22
3 ,,	28	29	30	28	27	30	31	31	32	29	30	29	30
4 ,,	28	30	25	24	23	26	31	30	30	24	26	27	27
5 ,,	19	20	14	11	11	17	23	22	19	12	14	18	17
6 ,,	3	2	6	9	8	1	7	7	3	9	8	0	1
7 ,,	21	23	29	31	30	18	9	12	18	32	31	25	23
8 ,,	48	48	51	54	46	31	23	28	38	51	54	50	44
9 ,,	68	68	65	63	54	39	33	38	49	63	67	67	56
10 ,,	68	69	64	60	52	41	37	40	50	59	60	65	55
11 ,,	50	51	50	46	43	31	32	34	40	38	40	43	42
Noon	19	21	25	25	28	21	21	22	19	12	11	12	20
1 P.M.	13	9	4	2	4	6	7	3	4	16	19	20	5
2 ,,	38	35	31	27	19	13	6	14	26	39	40	42	28
3 ,,	50	50	47	46	37	30	20	29	40	51	50	53	42
4 ,,	51	52	52	55	45	39	30	37	43	51	50	53	46
5 ,,	45	45	48	54	47	39	30	32	35	41	39	42	41
6 ,,	31	32	37	41	35	28	20	20	23	27	24	27	29
7 ,,	11	13	21	24	21	12	6	6	7	6	2	6	11
8 ,,	6	8	3	6	5	5	7	10	10	14	14	12	6
9 ,,	20	21	15	11	8	18	13	23	25	22	22	25	19
10 ,,	22	23	21	19	16	28	24	29	26	20	21	24	23
11 ,,	14	16	14	13	13	21	19	20	19	12	11	14	16
Midt.	4	6	6	3	3	7	6	7	4	0	2	4	4

LUCKNOW.—T. D. Years.
Lat. N. 26° 51′, Long. E. 80° 55′; Height, ? Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	9	17	11	15	15	1	4	9	10	18	23	13	12
2 ,,	22	28	16	23	22	9	8	18	17	24	30	19	20
3 ,,	29	32	22	24	18	7	12	22	14	26	35	25	22
4 ,,	31	28	17	13	8	2	8	18	8	20	29	24	17
5 ,,	17	13	2	3	1	13	2	7	3	6	16	14	5
6 ,,	1	1	16	29	24	34	15	10	19	16	4	7	15
7 ,,	22	24	42	49	40	42	30	27	36	36	25	32	34
8 ,,	46	50	66	66	55	52	35	42	47	51	50	60	51
9 ,,	61	63	72	70	57	51	41	47	57	61	62	70	59
10 ,,	52	62	67	65	54	49	36	46	53	54	52	66	55
11 ,,	26	45	48	48	42	40	28	26	59	32	30	41	39
Noon	12	17	20	26	21	22	16	17	21	9	22	7	18
1 P.M.	7	8	11	2	7	3	5	1	11	11	6	20	8
2 ,,	40	33	40	32	43	32	26	25	39	30	22	37	33
3 ,,	49	45	54	54	61	60	45	35	51	35	26	43	47
4 ,,	46	46	62	62	70	77	51	38	55	36	19	43	50
5 ,,	38	36	51	57	72	72	46	38	45	29	11	35	44
6 ,,	17	19	34	41	56	48	25	14	28	8	9	17	25
7 ,,	4	8	20	25	35	28	7	7	7	4	19	4	9
8 ,,	0	4	4	4	12	11	5	23	9	15	25	6	5
9 ,,	4	9	14	5	5	7	15	36	15	20	28	14	14
10 ,,	4	6	9	5	10	10	16	35	13	19	23	9	13
11 ,,	5	0	9	3	4	11	7	29	6	15	13	1	7
Midt.	5	7	1	5	10	4	6	2	4	8	16	6	4

* The time is 19 minutes earlier than hour specified.

TRIVANDRUM.*— ? YEARS.
LAT. N. 8° 31′, LONG. E. 77° 0′; HEIGHT, 130 Feet.

	Jan.	Feb.	Mar.	April.*	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	12	13	17	22	14	11	1	1	7	15	12	10
2 ,,	10	1	5	1	7	0	1	15	13	6	1	5	4
3 ,,	25	16	19	12	6	14	14	28	26	17	13	21	18
4 ,,	38	30	33	26	18	27	30	44	42	31	27	26	31
5 ,,	33	19	24	16	8	17	18	36	35	22	21	23	21
6 ,,	32	7	8	2	5	2	5	23	19	8	6	5	10
7 ,,	15	10	9	13	18	13	7	9	3	12	10	11	6
8 ,,	10	30	28	30	32	39	21	5	11	30	27	29	24
9 ,,	29	49	44	45	46	40	35	21	28	45	44	47	39
10 ,,	34	64	58	57	56	45	42	29	40	55	56	60	50
11 ,,	25	52	52	50	47	38	34	19	29	45	41	45	40
Noon.	1	32	27	28	28	21	18	9	11	25	15	21	20
1 P.M.	23	4	3	3	9	6	0	10	11	1	13	6	4
2 ,,	48	22	32	23	14	13	18	31	35	25	34	21	26
3 ,,	71	46	54	44	35	33	36	60	57	45	53	42	48
4 ,,	86	62	65	58	51	43	50	74	71	64	64	55	62
5 ,,	59	52	51	45	39	40	43	54	55	50	51	51	44
6 ,,	39	36	34	29	24	25	29	44	38	34	34	35	33
7 ,,	20	19	15	10	5	8	12	27	19	15	13	14	15
8 ,,	1	0	2	5	13	8	2	12	3	4	5	5	2
9 ,,	16	14	16	23	30	22	18	4	15	20	23	24	19
10 ,,	31	29	26	34	41	35	30	21	26	33	39	39	32
11 ,,	35	35	35	39	43	35	30	22	24	31	38	38	34
Midt.	25	23	26	30	34	24	21	13	14	22	26	26	24

SIMLA.†—THREE YEARS.
LAT. N. 31° 6′, LONG. E. 77° 11′; HEIGHT, 7487 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	4	7	12	16	11	2	5	13	12	8	10	9
2 ,,	9	15	18	23	23	19	10	13	20	20	17	16	17
3 ,,	18	24	28	29	27	21	17	18	23	26	22	22	23
4 ,,	24	27	32	30	22	19	16	17	22	25	24	29	24
5 ,,	21	26	26	24	15	12	11	12	14	19	19	25	18
6 ,,	17	16	18	12	2	2	2	5	5	10	9	15	9
7 ,,	3	4	3	2	11	9	9	6	8	5	7	0	4
8 ,,	16	13	12	18	22	19	16	15	13	21	23	20	13
9 ,,	32	28	25	29	30	29	22	23	30	31	34	36	29
10 ,,	37	36	32	34	34	29	26	27	34	33	36	40	33
11 ,,	30	33	31	31	33	28	23	24	30	26	25	32	29
Noon.	12	20	22	24	27	22	17	17	22	13	10	14	18
1 P.M.	2	5	8	13	17	13	7	6	8	1	3	0	6
2 ,,	9	7	4	2	4	3	5	6	6	10	10	9	5
3 ,,	14	14	12	13	9	8	16	17	15	15	15	13	13
4 ,,	14	17	15	16	17	18	26	23	18	14	17	15	18
5 ,,	12	14	13	18	20	20	29	24	17	12	14	15	17
6 ,,	6	9	7	12	16	15	21	18	14	4	6	5	11
7 ,,	1	0	2	1	8	10	12	7	4	3	1	2	3
8 ,,	7	7	12	9	0	2	2	4	5	10	6	9	5
9 ,,	12	11	16	13	5	4	8	12	7	12	9	13	10
10 ,,	10	11	17	12	4	7	12	15	6	10	8	12	10
11 ,,	7	8	12	8	2	5	13	13	4	4	2	5	7
Midt.	0	2	3	1	6	3	5	4	7	5	1	5	1

ADEN.*—TERM DAYS.
LAT. N. 12° 46′, LONG. E. 45° 53′; HEIGHT, 199 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	17	17	6	11	13	9	7	25	2	3	5	9	6
2 ,,	39	35	32	27	22	15	19	25	6	0	14	2	20
3 ,,	45	47	47	44	31	24	25	23	1	8	25	12	28
4 ,,	36	41	55	36	26	22	1	7	8	6	18	11	21
5 ,,	21	39	14	18	10	7	32	9	23	9	3	0	6
6 ,,	7	24	30	4	11	6	46	31	31	3	13	6	11
7 ,,	18	2	48	14	25	26	62	50	48	1	34	17	28
8 ,,	34	23	61	39	48	46	63	67	58	30	51	33	46
9 ,,	44	50	76	57	68	49	71	90	64	49	67	46	61
10 ,,	42	47	96	70	72	47	65	90	59	39	57	33	60
11 ,,	18	19	73	42	30	19	39	67	45	28	24	20	35
Noon	12	8	3	34	8	16	19	14	3	7	17	28	1
1 P.M.	14	31	38	13	3	1	18	6	35	35	48	50	22
2 ,,	26	66	61	2	32	24	40	31	46	38	59	56	40
3 ,,	41	76	75	42	61	39	69	57	69	58	63	67	60
4 ,,	38	56	68	61	53	47	79	63	67	50	55	62	58
5 ,,	20	47	57	49	35	35	82	73	59	37	37	40	48
6 ,,	2	29	31	28	22	30	70	60	41	15	14	13	29
7 ,,	14	3	17	11	1	9	40	39	37	1	2	9	11
8 ,,	25	18	6	1	6	3	12	14	14	16	9	12	5
9 ,,	24	20	18	12	12	9	10	15	2	33	21	41	18
10 ,,	22	40	32	30	24	22	24	11	18	49	26	55	30
11 ,,	10	10	33	14	5	11	15	5	10	13	21	37	14
Midt.	3	3	20	3	8	2	7	11	3	7	18	27	5

MAURITIUS.—TWELVE YEARS.
LAT. S. 20° 6′, LONG. E. 59° 48′; HEIGHT, 181 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	6	6	7	6	8	11	10	9	7	4	0	7
2 ,,	9	10	8	6	5	4	1	2	3	7	9	12	6
3 ,,	17	18	18	15	14	12	9	10	12	14	14	18	14
4 ,,	19	20	22	20	19	16	14	16	16	14	13	18	17
5 ,,	10	15	17	16	17	16	14	13	10	6	7	10	13
6 ,,	5	5	6	6	6	7	6	2	3	6	8	5	1
7 ,,	15	8	7	9	10	6	7	11	17	19	18	17	12
8 ,,	21	18	21	22	24	23	22	25	29	28	24	21	23
9 ,,	22	23	29	31	35	34	35	36	34	31	26	22	30
10 ,,	18	21	26	29	32	30	32	34	28	23	18	18	26
11 ,,	11	14	19	18	17	18	20	20	14	10	8	11	15
Noon	1	2	1	4	3	1	1	2	8	7	6	2	3
1 P.M.	11	13	16	21	23	23	21	21	25	24	21	13	19
2 ,,	25	26	29	34	36	35	35	37	41	39	35	26	33
3 ,,	35	34	37	39	38	37	39	42	47	45	42	36	39
4 ,,	40	37	36	35	34	33	35	38	44	44	43	39	38
5 ,,	33	31	29	25	24	24	26	30	34	34	32	31	29
6 ,,	18	17	16	13	12	12	16	17	18	16	15	15	15
7 ,,	0	1	1	2	3	1	2	3	0	3	3	3	1
8 ,,	14	17	17	20	17	15	12	13	17	19	20	16	16
9 ,,	26	29	30	29	25	22	20	22	28	30	29	26	26
10 ,,	33	35	33	30	25	25	23	23	30	32	34	33	30
11 ,,	30	32	28	25	23	22	20	22	26	28	29	30	26
Midt.	16	19	18	17	15	16	15	18	19	16	15	15	17

* The time is 11 minutes earlier than hour specified, and April is interpolated.
† Twenty-nine minutes to be added to each hour: thus, first hour is 1 hour 29 minutes A.M., etc.

NAPLES.—Three Years.
Lat. N. 40° 52′, Long. E. 14° 14′; Height, 489 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	8	5	3	2	2	2	0	4	3	2	2	3
2 ,,	5	4	1	1	3	3	5	6	3	4	0	2	1
3 ,,	2	5	8	8	8	7	9	10	9	11	5	0	6
4 ,,	4	9	7	14	11	8	10	15	11	13	9	3	10
5 ,,	7	10	8	12	8	7	8	13	12	15	11	5	10
6 ,,	11	10	9	5	2	2	3	6	6	15	7	2	6
7 ,,	7	5	4	1	4	1	2	2	0	10	1	3	1
8 ,,	3	2	2	6	8	6	9	8	6	1	7	9	5
9 ,,	5	7	7	11	10	9	11	13	15	6	12	20	10
10 ,,	11	11	9	13	13	10	11	16	18	10	18	23	14
11 ,,	8	13	7	12	13	9	11	14	15	8	15	24	12
Noon	2	6	13	5	8	9	11	1	10	9	2	2	6
1 P.M.	9	6	5	2	3	4	4	2	2	1	9	13	2
2 ,,	15	16	4	9	3	2	3	9	9	8	15	25	10
3 ,,	13	17	10	16	10	0	8	12	14	10	14	19	12
4 ,,	11	17	14	20	13	6	15	15	16	14	15	18	14
5 ,,	8	12	12	19	15	10	16	18	17	10	12	14	14
6 ,,	2	5	8	15	13	8	15	16	14	1	4	9	9
7 ,,	6	2	4	8	7	6	9	9	4	7	2	4	3
8 ,,	9	8	6	4	1	3	2	1	6	13	6	1	4
9 ,,	11	13	12	9	8	9	7	8	10	15	9	4	10
10 ,,	13	13	11	11	8	10	10	9	11	15	11	7	11
11 ,,	12	13	11	9	10	11	11	10	10	13	10	8	11
Midt.	3	11	7	9	8	7	8	6	6	7	7	4	7

POLA.—Four Years.
Lat. N. 44° 52′, Long. E. 13° 51′; Height, 104 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	6	8	1	2	2	1	2	2	6	7	3	2
2 ,,	4	2	4	7	7	5	3	2	6	1	6	2	1
3 ,,	2	4	3	11	11	10	6	6	10	6	2	3	6
4 ,,	3	11	7	14	14	11	7	9	12	9	1	7	8
5 ,,	8	12	8	14	12	7	5	7	12	9	3	12	9
6 ,,	8	11	7	10	8	3	0	4	9	9	4	11	7
7 ,,	6	9	2	4	3	2	5	2	4	3	2	9	3
8 ,,	2	1	5	2	2	9	11	7	4	6	8	0	5
9 ,,	9	7	12	8	6	12	13	13	12	12	9	9	10
10 ,,	15	11	17	13	10	16	16	17	16	16	17	17	15
11 ,,	14	15	17	17	13	17	17	19	16	16	16	15	17
Noon	5	12	17	15	12	18	14	16	13	10	5	5	12
1 P.M.	7	2	6	11	10	11	11	11	5	0	4	4	5
2 ,,	14	8	3	5	5	5	5	6	1	8	13	10	2
3 ,,	15	10	11	4	1	1	2	2	6	12	15	10	7
4 ,,	13	12	17	8	5	7	9	8	10	14	17	8	11
5 ,,	10	10	18	11	9	13	16	15	11	13	15	6	12
6 ,,	4	2	13	11	10	15	18	18	11	8	10	3	11
7 ,,	0	2	7	8	6	13	17	16	6	2	6	1	6
8 ,,	4	4	1	2	0	9	13	8	2	2	3	4	2
9 ,,	7	8	2	6	6	1	5	3	4	5	2	7	3
10 ,,	9	9	4	7	8	2	0	1	8	9	4	10	6
11 ,,	8	9	5	7	9	3	3	2	8	7	6	12	6
Midt.	5	6	4	6	7	1	3	1	6	6	6	12	5

TRIESTE.—Two Years.
Lat. N. 45° 39′, Long. E. 13° 46′; Height, 151 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	12	14	12	16	4	8	10	17	10	9	12	6	11
2 ,,	10	12	8	10	4	2	4	10	4	2	8	6	6
3 ,,	8	5	2	0	8	5	4	4	2	8	4	2	0
4 ,,	6	0	4	8	16	10	7	5	8	13	4	4	6
5 ,,	4	0	8	12	14	8	7	9	12	15	8	8	9
6 ,,	6	1	11	15	13	8	6	9	9	17	8	10	10
7 ,,	6	2	7	10	9	2	2	6	7	14	7	8	7
8 ,,	5	6	2	2	0	6	4	4	4	1	2	2	3
9 ,,	12	12	10	4	9	12	9	9	10	11	10	8	10
10 ,,	14	12	12	4	10	11	10	10	12	12	15	14	11
11 ,,	10	10	8	2	6	11	8	7	7	9	12	10	8
Noon	1	6	5	2	2	6	5	5	0	7	6	0	2
1 P.M.	10	0	0	7	0	2	0	1	6	1	13	8	4
2 ,,	26	10	9	12	5	8	9	6	10	8	25	18	12
3 ,,	26	16	15	14	7	11	10	8	12	11	24	16	14
4 ,,	24	16	20	14	9	14	10	10	13	12	21	14	15
5 ,,	22	14	20	13	11	12	11	11	12	10	17	13	14
6 ,,	15	10	14	8	9	8	9	12	8	4	9	6	10
7 ,,	7	4	2	2	6	4	4	6	0	3	1	2	3
8 ,,	2	2	6	10	4	6	4	3	10	8	6	3	6
9 ,,	12	6	15	20	14	14	15	14	15	11	16	14	14
10 ,,	12	9	18	22	16	18	19	16	15	11	16	14	16
11 ,,	11	8	18	19	16	16	17	16	15	10	16	18	15
Midt.	10	7	16	18	12	11	16	14	13	9	14	15	13

TURIN.—Six Years.
Lat. N. 45° 4′, Long. E. 7° 41′; Height, 906 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	10	7	8	4	4	4	4	6	6	3	5	5
2 ,,	1	3	1	3	1	1	1	1	2	4	2	4	2
3 ,,	1	5	8	1	2	3	2	3	4	4	3	2	3
4 ,,	6	8	12	2	2	0	1	3	6	7	6	3	5
5 ,,	10	8	8	2	6	6	6	4	4	7	8	10	3
6 ,,	6	5	0	10	14	11	13	8	4	6	9	6	2
7 ,,	2	2	9	17	20	18	20	19	11	2	2	1	10
8 ,,	11	7	15	22	24	23	24	24	17	14	6	9	16
9 ,,	20	11	22	26	25	23	23	26	26	20	13	20	21
10 ,,	29	13	23	26	24	21	20	27	27	20	15	28	23
11 ,,	23	12	17	20	18	17	14	20	13	19	9	21	17
Noon	9	4	6	4	7	11	7	6	6	6	7	4	4
1 P.M.	20	10	4	3	3	1	3	3	3	7	3	17	6
2 ,,	24	19	17	20	14	9	11	15	15	18	14	24	17
3 ,,	23	22	23	24	25	15	14	23	24	23	16	23	21
4 ,,	20	20	28	30	29	21	26	28	28	24	17	19	24
5 ,,	13	17	23	34	34	26	30	31	29	21	12	13	24
6 ,,	6	7	15	28	31	22	28	29	23	12	3	7	18
7 ,,	1	1	6	20	22	17	22	22	15	3	2	0	10
8 ,,	7	6	5	5	10	11	12	9	1	2	6	4	2
9 ,,	11	11	8	3	1	1	1	1	6	9	10	9	6
10 ,,	11	14	11	7	6	10	8	6	9	13	10	10	10
11 ,,	13	16	11	11	10	11	10	9	10	11	9	13	11
Midt.	7	13	9	11	10	7	10	9	9	7	9	8	9

MILAN.—NINE YEARS.
LAT. N. 45° 28′, LONG. E. 9° 9′; HEIGHT, 482 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	5	1	6	6	10	8	5	3	4	1	4	2
2 ,,	12	11	5	3	4	9	8	2	1	7	9	12	3
3 ,,	15	15	9	0	1	9	8	1	4	11	11	13	5
4 ,,	14	14	10	0	0	8	10	1	5	12	13	13	5
5 ,,	9	9	5	2	1	10	12	4	3	7	10	10	2
6 ,,	1	0	2	7	5	13	17	9	3	1	3	3	4
7 ,,	7	9	10	13	11	18	22	15	10	7	3	5	11
8 ,,	15	16	13	19	16	22	25	21	16	14	10	13	17
9 ,,	20	22	23	23	20	24	26	24	20	19	15	18	21
10 ,,	19	23	24	22	20	23	21	23	21	20	16	19	21
11 ,,	15	17	17	15	16	18	13	20	18	15	13	14	16
Noon	9	9	9	6	9	9	9	12	11	7	7	7	9
1 P.M.	1	0	3	5	1	3	4	0	1	2	1	2	2
2 ,,	9	8	13	15	11	14	15	10	9	10	8	9	12
3 ,,	15	17	22	24	20	24	26	20	18	17	12	14	19
4 ,,	16	18	26	29	25	31	32	26	26	19	14	16	23
5 ,,	14	15	24	30	27	34	34	29	24	17	12	12	23
6 ,,	4	11	11	24	23	32	31	26	20	12	6	7	17
7 ,,	1	3	2	16	16	16	25	23	13	4	0	0	10
8 ,,	9	4	9	7	8	17	17	9	5	4	2	7	2
9 ,,	11	8	13	2	0	8	8	5	1	9	7	1	3
10 ,,	11	10	12	7	5	1	1	2	6	12	12	12	7
11 ,,	4	7	7	11	9	6	4	5	8	11	10	9	8
Midt.	0	1	8	9	10	9	7	6	6	5	5	3	6

GENEVA.—TEN YEARS.
LAT. N. 46° 12′, LONG. E. 6° 9′; HEIGHT, 1335 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	2	1	2	8	9	9	6	1	1	4	1	2
6	6	5	1	4	6	6	2	3	7	9	6	2
9	9	6	1	2	4	4	1	5	10	12	11	4
11	10	4	1	4	5	6	2	3	10	12	13	4
9	7	1	5	8	8	9	6	2	7	8	12	1
3	1	5	10	13	12	14	10	9	1	0	6	5
6	7	11	15	17	15	18	15	15	9	9	3	12
14	15	17	19	18	16	19	18	19	17	17	12	17
20	20	20	20	16	15	18	18	22	21	21	18	19
20	21	20	18	13	12	13	15	20	19	19	19	17
14	17	15	12	6	6	8	10	14	13	12	13	12
4	7	7	4	1	0	1	2	5	3	2	4	3
6	3	4	4	9	7	7	6	6	7	8	6	6
14	14	15	16	17	15	15	15	16	16	15	13	15
18	19	22	24	24	21	22	23	24	21	17	16	21
16	20	25	27	28	26	27	27	27	21	15	13	23
10	15	22	26	29	27	29	27	26	16	9	8	20
4	8	15	20	24	24	27	23	19	8	3	2	15
2	1	6	11	16	17	20	15	10	0	3	4	7
6	5	3	2	5	8	11	5	1	7	7	7	0
7	8	9	5	5	2	1	4	7	11	8	9	6
6	8	10	9	12	9	7	11	10	12	7	9	9
4	6	8	8	14	12	12	12	10	9	5	7	9
2	2	4	6	12	12	12	10	6	5	1	4	6

GREAT ST. BERNARD.—TEN YEARS.
LAT. N. 45° 42′, LONG. E. 7° 7′; HEIGHT, 8127 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	0	4	1	2	1	3	7	4	2	4	0	0	1
2 ,,	8	6	9	8	8	6	5	2	7	12	6	7	7
3 ,,	12	12	13	14	12	10	11	7	13	16	10	9	11
4 ,,	16	15	17	18	14	13	19	12	17	18	12	10	15
5 ,,	14	13	16	16	12	13	17	14	16	16	11	9	14
6 ,,	11	11	14	13	10	11	14	11	11	13	9	7	11
7 ,,	6	6	11	10	6	8	10	7	6	5	4	3	7
8 ,,	1	1	7	6	3	5	7	4	1	2	1	2	2
9 ,,	5	1	2	1	0	3	4	2	3	7	3	9	1
10 ,,	10	3	2	2	2	2	2	1	6	10	5	15	4
11 ,,	6	3	3	3	3	1	1	0	5	9	2	10	3
Noon	2	2	3	3	4	0	0	1	3	6	1	2	2
1 P.M.	6	4	1	2	3	1	1	1	1	1	4	4	0
2 ,,	8	8	2	1	1	0	1	1	1	3	6	8	3
3 ,,	6	6	2	0	0	0	1	0	2	4	6	7	3
4 ,,	2	4	1	1	1	0	1	1	2	3	4	4	2
5 ,,	1	0	2	0	2	0	2	0	1	0	0	4	0
6 ,,	4	4	6	2	1	1	3	1	1	3	4	3	2
7 ,,	7	7	10	7	3	4	6	6	5	7	8	2	6
8 ,,	10	10	14	12	7	7	10	11	9	10	11	6	10
9 ,,	12	13	16	14	10	11	13	12	11	11	12	8	12
10 ,,	13	14	17	16	12	14	15	13	12	11	12	9	14
11 ,,	11	14	16	15	12	15	15	13	13	9	11	8	12
Midt.	8	12	11	12	10	13	13	10	10	4	8	5	10

BUCHAREST.—TWO YEARS.
LAT. N. 44° 25′, LONG. E. 26° 46′; HEIGHT, 305 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
7	8	4	9	2	5	4	3	1	4	4	3	4
4	6	1	5	2	1	2	3	2	2	4	0	2
0	0	4	4	3	3	2	1	4	3	1	2	1
4	4	6	0	5	2	2	1	5	3	4	8	3
7	5	5	1	1	5	2	3	1	2	4	6	2
9	6	1	5	10	11	8	8	6	1	3	3	2
2	2	4	13	19	20	12	14	14	4	5	1	9
2	8	11	18	28	24	16	20	22	15	16	6	16
11	11	15	22	29	28	18	22	28	19	20	15	20
18	11	14	23	31	27	18	21	29	21	22	21	21
17	12	14	20	25	25	18	20	24	20	19	16	19
8	9	4	10	18	14	11	11	15	10	5	6	10
3	3	3	3	6	3	0	2	2	3	6	8	1
14	16	14	10	6	10	8	7	12	14	14	14	12
14	18	18	20	20	20	14	17	20	18	15	16	18
10	17	21	28	26	25	20	21	26	24	18	14	21
8	15	22	30	30	34	23	26	27	20	16	11	22
4	9	19	29	31	32	23	26	27	14	10	5	19
1	0	10	23	28	26	18	22	20	8	2	2	13
3	4	2	8	16	20	15	10	9	3	0	1	6
3	10	6	2	5	6	2	3	4	3	1	5	1
5	12	9	5	2	1	0	1	0	6	6	8	4
8	12	9	7	2	1	3	4	2	8	5	10	6
7	10	9	8	3	5	2	4	2	8	4	6	6

KRAKAU.—NINE YEARS.
LAT. N. 50° 4′, LONG. E. 19° 55′; HEIGHT, 708 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	6	5	9	1	5	5	4	8	4	9	2	5
2 ,,	4	6	4	6	2	4	4	3	6	1	8	2	4
3 ,,	4	3	1	4	4	1	2	0	3	2	4	1	1
4 ,,	0	2	4	2	6	0	1	1	0	4	1	2	0
5 ,,	4	4	6	2	4	2	2	1	2	4	2	5	2
6 ,,	5	6	5	4	2	5	5	1	1	4	5	7	1
7 ,,	4	5	4	7	5	7	8	4	1	3	4	7	0
8 ,,	1	3	1	11	11	11	12	7	4	4	0	4	4
9 ,,	4	1	3	12	12	13	13	9	6	9	4	1	7
10 ,,	7	3	5	13	12	14	13	10	9	11	6	6	9
11 ,,	9	5	6	12	11	12	12	9	7	12	5	6	9
Noon	4	4	5	6	8	7	7	5	4	7	1	2	5
1 P.M.	2	3	1	2	1	1	2	1	2	0	6	3	1
2 ,,	7	9	5	7	5	8	5	6	6	6	13	7	7
3 ,,	6	10	7	9	8	10	7	10	9	8	12	6	9
4 ,,	5	9	10	12	11	12	10	12	11	11	11	4	10
5 ,,	5	7	9	13	13	15	12	13	12	10	9	4	10
6 ,,	3	3	6	13	12	15	12	12	10	6	4	2	8
7 ,,	2	1	2	9	8	13	10	10	7	3	1	1	5
8 ,,	1	4	3	3	4	11	5	3	1	1	3	3	1
9 ,,	2	5	6	1	2	3	1	2	1	2	6	6	2
10 ,,	3	7	8	3	3	2	3	4	4	4	7	7	4
11 ,,	4	8	9	4	4	0	5	7	4	4	8	8	5
Midt.	5	7	6	11	2	5	5	4	9	5	11	3	6

PRAGUE.—TWENTY-EIGHT YEARS, 1842–69.
LAT. N. 50° 5′, LONG. E. 14° 23′; HEIGHT, 660 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	4	5	5	5	6	7	4	4	2	2	1	4
2 ,,	5	2	3	3	4	5	5	3	4	0	1	1	3
3 ,,	4	2	1	1	2	3	2	2	3	3	2	2	1
4 ,,	1	7	3	1	3	4	3	2	1	6	5	6	1
5 ,,	2	9	4	2	7	3	6	4	2	4	6	8	1
6 ,,	3	7	1	7	13	12	11	9	5	3	6	8	2
7 ,,	0	4	4	13	17	16	14	13	10	5	2	5	7
8 ,,	6	5	7	15	18	18	17	16	15	12	6	2	11
9 ,,	11	6	10	17	18	18	15	17	17	15	9	12	14
10 ,,	14	8	13	16	16	15	13	16	17	17	13	14	14
11 ,,	13	9	10	11	13	12	9	12	12	14	10	11	11
Noon	2	5	7	4	4	7	4	2	5	6	2	2	4
1 P.M.	11	3	2	3	2	1	4	2	3	4	5	6	4
2 ,,	13	11	9	11	11	10	11	11	12	11	8	9	11
3 ,,	13	12	14	18	17	18	15	16	19	15	12	9	15
4 ,,	12	12	17	22	21	20	19	20	22	18	10	6	17
5 ,,	10	9	17	22	24	24	22	22	22	15	7	4	17
6 ,,	7	2	10	20	23	23	22	22	19	8	3	2	13
7 ,,	4	2	4	9	19	19	21	17	13	4	0	1	9
8 ,,	1	6	2	6	12	14	12	6	6	1	2	4	4
9 ,,	1	7	4	2	3	6	2	0	1	4	4	5	1
10 ,,	2	9	5	4	1	0	3	3	1	6	6	7	4
11 ,,	2	3	6	9	5	4	9	6	3	6	6	7	6
Midt.	6	6	6	6	5	7	7	5	6	3	5	2	5

EGER.—FOUR YEARS.
LAT. N. 50° 5′, LONG. E. 12° 22′; HEIGHT, 1517 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	2	1	4	4	4	4	2	2	2	3	0	2
2 ,,	2	0	2	1	1	0	0	0	1	1	4	0	1
3 ,,	4	3	4	3	2	2	2	1	3	4	7	3	3
4 ,,	7	4	4	3	2	1	1	1	4	4	8	4	4
5 ,,	6	4	3	2	2	3	3	8	2	4	7	5	2
6 ,,	6	3	0	4	9	7	10	7	3	1	4	5	2
7 ,,	2	1	4	10	11	15	14	11	3	5	0	2	6
8 ,,	4	6	8	15	17	17	18	16	14	11	7	5	11
9 ,,	10	12	14	16	17	17	17	18	18	15	15	14	15
10 ,,	13	14	15	14	15	15	15	17	17	18	15	17	15
11 ,,	11	12	12	11	11	11	12	12	13	14	12	12	12
Noon	4	4	6	3	3	3	5	5	5	5	3	3	4
1 P.M.	6	4	2	2	2	3	2	2	1	3	4	6	3
2 ,,	11	11	10	11	10	10	9	10	10	10	10	11	10
3 ,,	11	14	14	17	16	15	15	15	15	14	12	11	14
4 ,,	10	13	14	21	22	21	21	20	19	16	11	9	16
5 ,,	6	10	16	21	24	24	24	23	19	14	7	5	16
6 ,,	0	4	11	18	22	21	22	21	16	10	2	1	12
7 ,,	5	3	2	12	17	18	18	16	10	5	2	4	7
8 ,,	6	4	2	1	5	8	7	7	2	1	4	8	1
9 ,,	8	7	5	3	3	2	1	1	4	3	7	5	4
10 ,,	7	6	7	4	6	7	7	6	10	6	9	5	7
11 ,,	6	6	7	6	7	10	9	7	8	5	6	5	7
Midt.	3	3	4	5	6	9	7	5	7	4	4	0	5

VIENNA.—TEN YEARS.
LAT. N. 48° 12′, LONG. E. 16° 20′; HEIGHT, 638 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	8	7	9	6	7	6	7	7	3	0	6	6
2 ,,	6	5	4	5	4	5	5	6	6	0	2	2	4
3 ,,	4	1	3	2	3	1	3	4	4	6	7	1	0
4 ,,	0	7	7	3	1	0	4	3	2	8	11	6	3
5 ,,	5	10	9	3	4	3	9	4	2	9	14	12	3
6 ,,	8	13	7	4	12	9	13	9	6	10	15	4	1
7 ,,	4	7	2	11	17	13	19	13	11	2	9	11	5
8 ,,	7	7	9	16	21	18	21	18	16	13	7	4	12
9 ,,	15	13	14	19	22	19	22	20	22	18	12	12	17
10 ,,	13	15	16	21	21	19	20	21	19	20	17	18	19
11 ,,	13	14	10	13	15	15	14	15	14	17	13	12	14
Noon	2	9	6	5	10	9	6	7	7	10	3	3	6
1 P.M.	9	2	5	4	0	0	5	2	4	3	5	9	4
2 ,,	18	12	15	13	10	8	13	11	15	9	10	14	12
3 ,,	20	15	18	21	16	15	19	18	21	12	10	13	17
4 ,,	19	16	22	25	22	18	24	23	24	15	9	12	20
5 ,,	17	16	20	27	28	24	28	27	26	15	5	7	21
6 ,,	11	10	14	26	30	26	27	29	25	10	0	6	18
7 ,,	5	3	6	18	24	21	23	23	18	6	5	2	12
8 ,,	2	2	4	8	13	15	16	13	8	1	8	3	5
9 ,,	7	7	10	4	14	3	5	4	1	4	13	8	2
10 ,,	12	12	14	11	1	2	3	4	6	3	17	11	8
11 ,,	12	9	13	14	4	5	9	6	8	6	15	12	9
Midt.	11	11	9	11	7	9	6	7	8	7	3	12	8

SÄNTIS.—THREE YEARS.
LAT. N. 47° 15′, LONG. E. 9° 20′; HEIGHT, 8094 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	2	1	2	5	1	2	2	3	4	6	3	0
2 ,,	2	1	3	3	11	8	9	7	7	0	5	3	3
3 ,,	0	3	9	10	14	15	15	11	10	6	0	5	8
4 ,,	4	6	13	13	20	19	17	16	15	9	3	8	12
5 ,,	7	8	15	16	19	20	18	16	16	11	6	10	13
6 ,,	8	8	14	13	18	16	15	15	13	13	7	10	12
7 ,,	7	5	10	9	11	11	12	12	7	8	5	7	9
8 ,,	3	2	6	7	8	8	6	7	1	4	1	2	4
9 ,,	1	2	3	3	6	5	3	3	4	1	5	4	1
10 ,,	7	5	2	2	1	1	2	2	8	3	10	11	4
11 ,,	7	7	2	4	0	4	4	4	8	6	8	8	5
Noon.	0	7	3	3	2	7	6	5	8	2	3	1	4
1 P.M.	6	1	0	6	4	6	6	6	6	2	2	5	2
2 ,,	8	4	3	5	3	7	7	5	3	2	5	6	0
3 ,,	7	5	3	4	3	6	7	5	1	3	5	5	0
4 ,,	4	4	3	2	3	4	6	4	0	3	4	2	0
5 ,,	1	3	1	3	3	3	5	3	1	3	3	1	0
6 ,,	2	1	3	3	5	4	4	3	1	2	1	1	2
7 ,,	4	4	9	4	7	5	5	6	4	5	0	5	5
8 ,,	6	5	12	8	11	8	9	10	7	7	0	6	7
9 ,,	7	7	14	10	16	14	12	12	8	9	1	7	9
10 ,,	6	6	14	9	16	15	10	10	8	10	2	8	10
11 ,,	6	5	12	5	11	12	9	7	5	6	1	7	7
Midt.	3	3	10	3	10	7	2	4	2	3	0	4	4

KLAGENFURT.—SIX YEARS.
LAT. N. 46° 37′, LONG. E. 14° 18′; HEIGHT, 1437 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
15	15	18	16	13	15	17	16	12	9	9	8	14
13	14	16	16	13	16	18	16	11	8	8	6	13
13	13	15	15	13	16	19	16	10	7	9	6	13
12	13	16	13	15	18	21	18	10	7	11	5	13
13	14	16	13	18	22	25	21	11	8	10	4	14
15	16	20	15	22	23	30	25	14	8	10	6	17
17	20	24	20	26	25	32	29	17	11	12	10	20
17	20	25	20	25	23	30	29	19	13	18	12	21
16	19	25	17	21	18	27	26	20	13	15	12	19
12	15	19	12	14	11	20	18	16	12	12	13	15
2	6	10	5	4	2	10	3	9	9	5	6	6
10	5	3	7	6	8	2	4	1	1	4	4	4
20	17	18	16	16	19	20	16	10	11	17	16	16
26	29	32	26	26	29	32	27	23	21	25	22	27
27	33	40	32	33	35	41	37	29	24	29	24	32
25	34	46	34	36	38	50	42	33	27	28	21	35
22	30	41	34	39	37	49	44	31	25	22	17	33
15	22	34	29	34	32	43	41	28	20	16	11	27
10	13	19	19	25	24	33	31	17	10	8	5	18
3	6	10	8	12	12	16	15	6	2	0	1	7
3	3	4	5	4	4	1	0	3	6	6	7	4
4	6	9	9	10	10	5	7	8	9	10	8	8
5	8	12	12	12	13	11	12	11	10	9	9	10
6	10	15	15	17	15	15	15	13	11	10	9	13

GRIES.—TWO YEARS.
LAT. N. 46° 30′, LONG. E. 11° 20′; HEIGHT, 958 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	14	19	21	25	25	26	25	19	19	7	8	18
2 ,,	5	15	19	21	23	25	25	28	20	19	6	7	18
3 ,,	7	14	18	19	22	24	25	28	19	17	5	7	17
4 ,,	2	9	13	17	21	28	28	32	19	15	1	3	16
5 ,,	0	8	13	20	25	34	35	37	23	17	1	1	18
6 ,,	1	11	18	26	30	40	40	45	30	21	2	1	22
7 ,,	6	15	25	32	35	40	42	47	35	25	8	5	26
8 ,,	15	26	34	36	35	35	35	45	38	33	18	14	30
9 ,,	20	28	34	33	28	28	30	38	36	33	22	19	29
10 ,,	19	25	26	23	17	15	16	23	24	25	20	19	21
11 ,,	15	18	17	13	6	2	2	5	11	15	15	15	11
Noon	4	5	2	4	12	15	16	16	8	5	1	0	6
1 P.M.	11	14	16	23	28	35	35	36	27	23	16	14	23
2 ,,	20	30	33	36	38	45	49	52	44	38	27	25	37
3 ,,	29	38	44	47	47	54	58	63	54	46	32	28	45
4 ,,	28	41	50	54	52	58	62	69	58	48	31	26	48
5 ,,	26	40	50	54	51	57	60	65	55	44	28	22	46
6 ,,	17	27	41	45	43	47	51	55	44	31	16	12	36
7 ,,	9	19	28	33	33	35	36	38	28	19	6	6	24
8 ,,	1	8	13	14	13	14	13	16	11	8	1	1	9
9 ,,	5	0	0	1	2	4	7	2	4	0	7	4	3
10 ,,	11	8	8	11	11	14	18	13	13	7	14	9	11
11 ,,	12	10	13	17	18	21	25	19	18	9	11	10	15
Midt.	14	14	18	21	22	25	30	24	22	10	16	11	19

OBIRGIPFEL.—FIVE AND A HALF YEARS.
LAT. N. 46° 30′, LONG. E. 14° 27′; HEIGHT, 6706 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
5	1	4	4	2	1	2	3	2	0	4	1	2
4	1	0	3	8	7	6	1	2	3	1	1	2
4	4	7	9	13	15	10	8	7	7	2	3	7
1	10	12	12	18	18	12	10	12	10	6	5	11
6	13	14	17	20	17	11	15	15	13	7	7	13
8	12	14	15	17	14	8	14	15	14	9	8	12
7	11	11	13	13	9	3	9	10	10	6	7	9
1	4	5	8	6	2	1	4	5	2	2	2	3
7	4	1	3	1	1	4	1	1	4	3	3	2
11	6	7	2	5	6	7	6	7	9	9	11	7
12	10	8	7	8	10	10	9	9	11	13	14	10
7	10	7	6	9	8	10	10	10	9	7	8	8
3	5	5	7	9	10	9	8	8	5	0	0	5
9	2	1	6	6	7	6	4	5	0	7	7	1
12	5	5	4	5	4	4	2	2	2	8	9	2
10	6	6	1	2	1	1	0	1	3	7	7	3
9	4	6	0	1	1	4	4	3	3	5	5	4
5	2	3	1	2	3	7	6	4	1	1	2	3
2	2	2	1	0	1	5	3	0	2	1	1	0
1	5	7	7	4	1	1	2	4	5	3	3	3
3	6	11	12	12	11	4	6	7	9	4	4	7
4	8	12	13	14	11	6	9	8	9	6	6	9
4	8	12	10	15	10	6	9	8	8	6	6	9
2	6	9	7	11	7	6	8	5	5	4	5	7

SCHAFBERG.—Two Years.
Lat. N. 47° 46′, Long. E. 13° 26′; Height, 5827 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	4	2	2	1	1	0	3	2	4	2	3	2
2 ,,	0	0	4	5	8	6	7	4	3	2	2	2	3
3 ,,	4	7	8	13	14	11	12	11	8	1	0	3	8
4 ,,	7	11	11	16	16	13	14	14	12	5	3	8	11
5 ,,	11	12	16	16	15	11	12	13	12	7	7	10	12
6 ,,	10	12	15	15	12	9	10	10	10	6	5	6	10
7 ,,	6	8	10	10	7	4	6	6	6	2	1	3	6
8 ,,	1	2	4	6	4	2	2	2	0	2	3	0	1
9 ,,	4	2	2	1	0	2	2	3	4	6	5	4	3
10 ,,	7	6	5	4	4	4	6	7	11	11	10	8	7
11 ,,	8	9	10	8	8	7	8	9	11	10	9	7	9
Noon	6	6	9	8	7	7	7	7	7	5	3	2	7
1 P.M.	2	0	5	5	6	6	6	5	5	0	3	7	2
2 ,,	6	6	2	2	5	3	2	2	1	4	6	10	1
3 ,,	6	6	2	1	3	2	2	0	1	6	8	11	3
4 ,,	4	4	2	1	1	2	2	3	3	7	7	8	4
5 ,,	2	2	2	2	2	4	4	5	3	6	4	4	3
6 ,,	3	2	2	1	1	4	4	4	2	1	2	1	1
7 ,,	4	7	6	6	2	2	2	2	3	3	4	4	3
8 ,,	6	8	10	10	8	3	3	4	8	6	6	5	6
9 ,,	6	8	11	11	11	8	9	8	11	8	8	7	9
10 ,,	6	8	7	11	9	10	10	9	10	8	9	8	9
11 ,,	5	6	6	10	8	10	11	9	8	6	7	6	8
Midt.	3	4	4	7	5	7	7	6	6	4	4	5	6

SALZBURG.—Six Years.
Lat. N. 47° 48′, Long. E. 12° 57′; Height, 1362 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
5	4	10	10	9	15	14	7	7	7	3	2	7
4	2	8	5	6	10	10	3	4	5	4	1	5
4	3	3	3	4	5	6	2	3	0	6	0	2
1	9	1	1	4	5	5	1	2	1	7	2	0
3	12	1	2	6	9	6	1	1	1	8	4	0
2	12	3	6	12	14	9	7	4	0	7	3	3
3	9	8	11	15	16	12	12	8	4	2	1	7
8	1	14	12	17	18	13	14	12	12	6	5	11
13	5	17	12	16	14	11	14	14	14	10	10	13
14	8	17	11	13	10	9	13	14	13	13	13	12
14	12	12	6	8	5	5	7	9	11	11	9	9
1	6	5	2	2	2	1	2	4	2	2	1	1
12	3	6	9	9	11	10	5	4	11	7	11	8
17	10	14	16	16	18	15	13	11	18	12	15	15
23	13	19	23	23	24	20	20	18	22	12	14	19
13	15	22	25	27	29	23	24	20	23	9	11	21
10	10	21	23	29	31	27	26	19	18	5	7	19
5	1	16	18	25	27	25	23	16	9	2	3	14
2	0	7	9	18	19	18	14	8	5	6	0	8
0	9	1	2	6	9	8	0	1	3	8	3	0
3	12	5	9	5	6	5	8	2	8	9	6	6
3	14	5	11	12	11	8	11	3	12	8	7	9
8	13	6	14	15	14	16	14	4	12	6	7	10
9	7	11	12	12	18	18	10	9	8	2	5	10

KREMSMUNSTER.—Four Years.
Lat. N. 48° 4′, Long. E. 14° 8′; Height, 1260 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	10	6	2	6	2	0	6	2	4	2	0	7	2
2 ,,	7	6	2	1	0	2	0	2	2	4	1	7	1
3 ,,	4	8	7	2	2	4	0	3	0	7	3	6	3
4 ,,	0	11	8	3	2	3	2	3	0	9	6	8	4
5 ,,	4	12	6	2	3	2	6	0	1	8	4	8	3
6 ,,	4	6	0	6	14	9	12	6	6	4	1	4	3
7 ,,	0	2	8	17	23	18	23	18	17	5	5	1	11
8 ,,	4	10	14	22	26	24	25	23	23	12	12	4	17
9 ,,	8	17	18	26	26	24	24	25	27	18	18	11	20
10 ,,	16	21	20	26	22	22	19	23	28	19	23	15	21
11 ,,	14	21	20	19	13	16	14	18	21	16	19	14	17
Noon.	1	13	12	7	4	8	3	10	11	6	6	1	7
1 P.M.	10	3	2	2	5	0	6	1	3	5	4	9	3
2 ,,	16	9	8	12	14	9	14	8	12	12	11	14	12
3 ,,	15	12	14	20	21	16	20	16	21	18	14	14	17
4 ,,	12	14	19	24	26	21	26	22	24	20	13	11	19
5 ,,	10	14	18	24	27	23	27	24	23	16	10	6	19
6 ,,	6	8	11	22	26	23	27	24	22	10	7	2	16
7 ,,	2	3	8	17	20	20	20	20	16	6	6	2	11
8 ,,	2	1	2	7	12	13	10	10	10	0	4	3	5
9 ,,	5	6	5	0	0	0	3	1	1	10	1	11	3
10 ,,	4	6	6	2	4	4	5	2	3	11	1	11	5
11 ,,	2	6	5	2	10	6	7	3	4	11	2	10	5
Midt.	2	6	3	2	10	4	8	4	4	6	2	6	4

MUNICH.—Ten Years.
Lat. N. 48° 9′, Long. E. 11° 36′; Height, 1708 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
3	2	4	2	2	5	4	3	3	2	0	3	2
4	0	0	2	0	2	1	0	0	2	1	2	0
3	5	4	4	3	1	2	3	4	5	4	3	3
1	8	7	5	3	1	2	4	6	6	6	5	5
4	8	6	4	0	2	0	3	5	6	6	7	4
4	8	4	2	6	5	2	1	0	5	6	6	1
0	4	2	8	12	10	9	6	5	2	2	2	4
4	4	6	12	15	12	12	9	10	8	6	4	9
10	7	11	14	15	12	12	12	12	13	11	11	12
13	10	11	15	13	11	11	12	14	12	12	15	12
11	12	10	12	11	8	8	11	12	11	11	11	11
1	6	6	5	5	4	4	5	6	4	2	2	4
9	2	1	0	2	4	3	0	0	4	4	6	3
12	7	7	7	8	10	7	6	6	9	10	10	8
9	10	12	15	14	14	12	11	12	12	9	8	10
8	9	14	18	18	18	16	14	14	12	8	5	12
5	7	12	18	20	20	19	17	15	10	4	4	13
3	1	7	15	19	17	17	15	12	3	1	1	9
1	3	0	7	12	12	11	9	5	1	3	2	4
2	4	4	3	4	4	4	0	2	4	4	4	1
4	6	7	5	4	4	4	4	4	6	5	5	5
3	6	8	7	6	9	9	8	6	7	5	6	7
3	6	6	9	9	11	11	9	5	5	4	6	7
0	5	4	8	7	10	10	8	4	4	3	4	6

BERNE.—Ten Years.
Lat. N. 46° 57′, Long. E. 7° 35′; Height, 1883 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	11	7	9	7	11	9	7	9	7	8	1	7
2 ,,	1	10	4	6	5	6	7	5	8	6	6	2	5
3 ,,	0	6	2	2	4	3	4	2	6	2	2	3	3
4 ,,	3	3	2	2	4	3	4	0	4	0	2	6	1
5 ,,	6	2	4	1	2	3	5	2	2	0	5	5	0
6 ,,	7	0	3	3	9	5	8	4	5	0	4	4	1
7 ,,	5	1	1	7	11	7	10	7	7	5	0	1	4
8 ,,	1	4	2	9	11	8	11	8	9	9	3	1	6
9 ,,	5	7	3	10	8	7	8	8	10	11	7	6	8
10 ,,	11	11	5	13	7	4	6	7	10	11	12	12	9
11 ,,	13	11	5	9	5	2	3	3	6	7	11	10	7
Noon	5	6	1	1	1	2	1	2	1	2	4	1	1
1 P.M.	8	6	7	9	11	7	9	10	13	9	8	10	9
2 ,,	13	14	8	12	15	11	12	11	15	15	14	9	12
3 ,,	10	15	13	17	18	13	14	14	16	17	15	8	15
4 ,,	9	14	13	19	19	14	15	16	19	23	19	5	15
5 ,,	7	12	11	22	19	15	17	16	18	15	5	5	14
6 ,,	2	10	7	15	17	13	16	15	14	9	5	2	10
7 ,,	1	4	1	9	11	9	13	9	5	3	2	1	5
8 ,,	4	2	4	1	4	4	11	1	2	1	1	4	1
9 ,,	6	1	8	6	6	5	2	3	3	6	5	6	4
10 ,,	9	3	11	9	10	11	6	10	6	8	6	8	8
11 ,,	9	4	12	11	12	12	10	12	6	9	6	9	9
Midt.	7	4	11	10	12	12	11	12	7	9	5	7	9

PARIS.—Six Years.
Lat. N. 48° 30′, Long. E. 2° 20′; Height, 216 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	7	2	6	5	0	3	2	0	2	5	0	2
4	7	0	2	0	4	1	7	4	1	8	5	2
10	4	1	1	2	6	4	10	7	6	11	10	5
13	0	3	0	1	3	2	10	6	8	11	14	6
13	4	3	4	4	2	3	3	2	8	10	14	4
8	5	1	8	9	8	8	5	4	3	4	10	1
0	2	4	12	13	12	14	13	11	4	3	2	7
8	3	11	16	15	14	16	17	16	11	10	6	12
13	9	16	17	15	13	15	17	19	16	14	12	15
14	12	19	15	12	11	13	15	13	15	15	14	14
11	10	16	10	7	8	8	11	13	10	11	9	10
4	3	8	2	1	5	4	6	6	0	4	2	4
4	6	3	7	5	1	2	0	2	9	4	5	4
8	14	12	15	11	7	8	6	9	17	8	9	10
11	19	20	22	17	14	14	12	15	19	9	10	16
10	18	20	26	22	19	20	17	18	17	6	7	17
7	11	17	24	23	21	23	19	18	12	2	3	15
2	3	11	19	19	19	21	17	14	4	2	1	10
2	2	3	11	12	13	15	11	7	2	5	5	5
5	5	2	2	4	4	6	2	0	6	6	7	1
8	6	4	6	6	6	4	6	4	9	5	9	6
9	5	5	10	10	11	10	11	7	10	2	10	8
8	5	5	12	11	12	11	12	6	9	0	9	8
6	6	3	9	8	7	7	7	3	7	2	6	6

VENDÔME.—Two Years.
Lat. N. 47° 47′, Long. E. 1° 4′; Height, 281 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	13	4	6	5	1	5	4	4	4	0	0	2
2 ,,	7	16	2	4	7	2	8	6	2	9	1	2	4
3 ,,	8	17	1	2	7	4	8	5	2	12	2	5	5
4 ,,	9	16	3	2	5	2	6	4	2	15	4	7	6
5 ,,	9	15	1	6	2	2	1	2	4	12	6	10	4
6 ,,	8	13	4	12	4	9	9	4	9	2	0	10	2
7 ,,	4	6	10	18	9	12	14	9	13	9	4	6	7
8 ,,	9	7	15	22	13	16	16	11	18	14	11	4	13
9 ,,	18	11	20	24	14	16	14	13	20	18	16	11	16
10 ,,	24	13	20	21	14	15	13	13	19	19	19	20	18
11 ,,	24	18	17	16	9	12	10	8	12	14	10	18	14
Noon	11	10	10	6	3	7	6	1	2	2	3	7	5
1 P.M.	3	2	3	3	3	2	0	2	7	7	14	3	4
2 ,,	10	11	16	14	10	7	6	9	16	13	19	10	12
3 ,,	10	13	24	22	17	12	13	15	21	16	16	12	16
4 ,,	8	11	28	28	20	18	19	18	24	16	12	8	18
5 ,,	8	6	23	27	21	20	22	20	22	14	6	7	16
6 ,,	4	2	15	24	15	19	22	17	18	6	1	3	12
7 ,,	3	9	8	16	8	13	14	8	11	3	5	1	5
8 ,,	3	12	1	7	0	8	6	1	4	4	9	5	1
9 ,,	2	14	3	2	10	2	3	10	1	11	11	6	6
10 ,,	1	15	6	1	14	5	6	13	2	13	13	6	8
11 ,,	1	14	6	1	12	4	7	12	0	13	13	6	7
Midt.	4	11	5	0	8	1	5	9	4	10	11	4	5

LYONS.—Two Years.
Lat. N. 45° 46′, Long. E. 4° 49′; Height, 574 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
3	18	13	1	7	13	6	3	5	4	4	2	6
1	14	10	7	2	10	5	0	2	1	1	3	3
0	6	7	8	0	6	4	1	1	3	4	5	0
4	1	6	10	2	6	4	1	3	6	7	9	2
6	0	7	7	4	8	9	2	1	3	7	9	0
4	1	13	1	9	12	14	7	2	2	5	6	3
2	4	19	10	14	17	20	15	11	6	2	2	10
4	8	27	13	17	17	24	17	16	17	11	9	15
11	11	30	16	15	14	23	16	20	22	17	15	18
17	13	28	14	13	10	20	15	19	23	22	19	19
17	11	21	13	8	6	15	11	13	20	19	12	14
6	2	10	6	2	0	8	4	10	10	6	0	5
7	11	8	2	5	11	3	4	5	7	9	12	7
14	21	21	10	11	18	12	12	16	13	18	16	15
15	26	29	14	17	24	19	17	22	17	20	16	20
12	25	35	21	20	28	26	23	25	19	18	15	22
7	23	35	19	23	29	30	23	22	18	14	9	21
4	16	29	14	20	26	30	23	18	9	6	3	17
1	7	20	7	10	20	25	17	9	5	0	2	10
1	0	11	3	5	10	17	4	2	3	2	5	3
3	3	5	9	3	5	5	5	6	0	5	7	3
3	7	0	12	7	13	2	11	8	2	6	10	7
5	8	2	13	9	15	4	12	9	2	6	12	8
3	9	5	13	8	17	7	14	9	2	6	12	9

MADRID.—Five Years.
Lat. N. 40° 24′, Long. E. 3° 45′ ; Height, 2149 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
*1 A.M.	4	3	1	2	8	9	9	6	1	3	2	4	2
*2 ,,	12	10	6	1	6	9	8	5	2	9	10	11	3
3 ,,	17	15	8	2	5	9	7	4	4	14	14	16	5
*4 ,,	20	18	6	4	8	12	13	8	2	14	14	18	5
*5 ,,	15	9	1	9	13	18	19	15	4	6	8	15	4
6 ,,	6	1	6	16	17	23	23	20	11	2	2	6	9
*7 ,,	8	10	14	21	25	28	30	29	23	15	14	6	19
*8 ,,	17	22	24	30	28	30	35	34	30	26	25	15	26
9 ,,	24	30	28	32	26	29	33	34	34	32	29	23	29
*10 ,,	25	32	26	28	22	23	25	27	31	29	28	25	27
*11 ,,	18	26	20	19	14	17	15	16	22	20	18	18	19
Noon	7	18	11	6	3	8	11	11	10	8	5	6	9
*1 P.M.	5	8	3	6	8	6	5	5	6	5	6	3	6
*2 ,,	15	23	23	26	26	24	19	21	22	19	17	12	21
3 ,,	20	25	29	33	34	30	25	28	28	25	22	14	26
*4 ,,	19	27	34	36	37	42	39	40	32	25	20	12	31
*5 ,,	13	21	29	34	39	44	46	45	31	22	17	8	29
6 ,,	6	17	21	30	34	40	41	40	29	17	13	3	24
*7 ,,	3	8	10	17	20	22	23	22	20	5	4	3	11
*8 ,,	9	2	2	5	6	13	15	13	10	4	4	7	3
9 ,,	11	4	4	1	3	4	9	4	1	6	6	9	2
*10 ,,	10	4	8	3	10	1	2	1	2	7	6	9	5
*11 ,,	8	5	9	5	13	4	0	4	4	6	4	7	6
Midt.	7	6	9	6	11	6	2	5	6	5	3	5	6

COIMBRA.—Seven Years.
Lat. N. 40° 12′, Long. W. 8° 23′ ; Height, 462 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	4	10	0	0	1	3	6	1	1	2	1	2
1	1	2	9	6	6	1	1	4	6	4	0	3
4	7	6	14	11	10	5	4	8	11	9	4	8
9	11	8	16	12	10	5	6	9	11	12	9	10
13	11	6	16	9	6	2	4	7	9	12	12	9
10	8	2	9	2	1	3	1	2	7	10	7	5
2	1	6	2	4	6	7	7	5	1	1	1	2
9	10	14	3	9	10	11	12	15	12	10	9	10
24	21	25	11	14	12	16	17	23	22	23	22	19
29	26	27	14	15	13	17	19	24	23	26	29	22
23	23	22	10	11	10	13	12	18	19	22	22	17
6	9	10	1	2	4	1	0	3	4	4	3	4
11	10	6	4	8	6	8	11	12	10	9	12	9
19	21	18	10	13	10	13	17	19	15	15	19	16
21	26	25	16	18	14	17	21	25	18	15	19	20
18	24	27	19	19	16	19	21	23	18	12	15	19
14	18	25	14	17	15	20	20	19	14	7	11	16
5	9	14	8	13	11	18	15	13	4	2	6	9
1	1	3	0	4	3	8	6	2	3	7	1	1
5	5	5	14	6	7	1	8	10	9	10	4	7
8	9	11	22	16	21	15	19	15	11	14	8	14
9	13	13	22	18	22	16	19	15	11	13	10	15
7	12	9	19	16	19	14	17	12	8	11	10	13
3	9	5	12	10	11	9	11	8	3	7	4	8

LISBON.—Ten Years.
Lat. N. 38° 43′, Long. W. 9° 8′ ; Height, 312 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	2	4	1	3	5	1	2	0	2	0	1	1
2 ,,	4	3	5	7	9	11	7	9	7	7	3	3	6
3 ,,	6	11	13	13	14	15	12	13	13	17	9	5	12
4 ,,	13	14	17	17	17	22	12	15	15	17	12	11	15
5 ,,	17	13	14	13	12	9	8	11	11	13	11	14	12
6 ,,	13	9	8	4	5	3	2	2	3	8	6	9	6
7 ,,	3	1	2	6	3	6	6	7	6	1	4	1	3
8 ,,	8	13	11	11	9	16	13	15	16	15	15	10	13
9 ,,	25	24	20	20	15	17	16	21	26	25	26	24	22
10 ,,	33	28	23	22	16	22	18	23	28	27	28	31	25
11 ,,	27	28	20	17	13	17	16	19	21	20	21	26	20
Noon	5	13	11	3	6	9	7	7	9	4	0	0	7
1 P.M.	10	4	2	1	2	1	0	1	1	4	11	7	3
2 ,,	20	18	13	9	6	6	7	8	11	16	20	15	12
3 ,,	20	22	19	18	12	12	13	12	17	18	21	22	17
4 ,,	17	22	20	19	15	15	16	17	20	17	19	18	18
5 ,,	13	18	18	16	13	17	18	19	19	13	15	14	16
6 ,,	6	10	11	14	11	13	16	18	16	6	8	7	11
7 ,,	1	2	4	7	3	7	10	10	8	2	1	1	4
8 ,,	6	3	5	5	4	0	2	2	4	8	2	4	3
9 ,,	10	8	11	14	15	12	10	12	11	16	8	7	11
10 ,,	12	10	13	14	15	13	12	12	10	14	9	9	12
11 ,,	12	10	13	13	13	12	12	11	8	10	8	10	11
Midt.	11	6	8	8	6	9	6	7	3	5	4	4	6

SAN FERNANDO.—Five Years.
Lat. N. 36° 28′, Long. W. 6° 15′ ; Height, 92 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
5	0	6	5	5	0	3	2	3	3	2	4	3
2	3	2	0	1	5	0	2	2	1	2	6	2
0	6	2	4	5	7	1	4	6	5	5	9	4
4	9	6	6	6	6	0	2	6	6	7	11	6
5	9	5	5	5	3	4	0	4	4	6	9	4
3	6	2	2	3	2	8	4	0	1	0	6	1
4	2	3	3	1	7	12	10	6	9	9	2	6
13	11	10	11	6	11	15	15	13	17	19	12	13
20	20	16	14	9	14	17	20	19	23	26	19	18
22	24	19	17	12	17	18	22	22	22	25	22	20
17	20	15	15	12	17	16	21	19	17	17	18	17
6	10	7	9	9	15	13	16	11	5	4	7	9
9	9	4	0	2	7	4	6	0	8	3	5	2
21	17	15	11	6	3	6	6	12	19	22	14	13
28	23	23	20	14	13	16	19	22	25	27	22	21
26	23	25	26	19	22	24	27	27	26	25	20	24
18	17	22	24	20	25	28	30	26	20	17	14	22
9	7	15	18	16	22	27	26	19	13	8	3	15
0	2	6	9	7	14	20	18	8	4	1	6	7
6	8	4	1	2	5	10	7	2	3	4	10	1
7	10	10	9	10	4	0	2	9	7	6	12	6
7	8	13	13	14	6	6	7	12	9	6	9	9
6	6	12	13	14	9	8	8	11	9	5	5	9
6	3	10	10	14	5	7	6	7	6	4	1	7

* Hours interpolated.

VALENTIA.*—Six Years.
Lat. N. 51° 55′, Long. W. 10° 18′; Height, 23 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	8	4	2	3	1	1	2	2	9	15	3	2
2 ,,	9	2	0	3	3	7	7	4	1	14	11	1	3
3 ,,	10	4	7	7	9	14	13	9	8	19	7	2	8
4 ,,	15	10	13	11	13	20	16	17	12	20	2	7	13
5 ,,	19	12	13	13	14	19	15	16	16	20	1	12	14
6 ,,	21	11	11	8	10	16	12	13	11	17	2	13	12
7 ,,	18	9	8	5	8	12	8	8	5	13	1	11	9
8 ,,	11	2	3	1	3	7	3	3	1	3	6	6	3
9 ,,	1	3	0	1	0	3	2	1	6	5	10	0	2
10 ,,	8	8	5	5	3	1	1	3	10	11	15	7	6
11 ,,	14	13	7	8	5	5	3	6	12	13	15	9	9
Noon	12	14	7	7	6	7	4	7	10	12	8	4	8
1 P.M.	4	7	5	5	5	7	3	7	9	8	4	4	4
2 ,,	2	0	2	3	4	6	3	7	4	4	12	10	1
3 ,,	4	6	7	1	1	6	1	4	1	1	19	12	3
4 ,,	1	7	9	5	4	4	2	0	4	1	17	6	4
5 ,,	1	6	8	5	4	3	3	0	5	1	15	1	4
6 ,,	5	0	4	3	4	4	1	1	4	4	10	5	1
7 ,,	7	4	3	1	2	5	2	0	2	10	7	7	2
8 ,,	11	4	5	5	3	7	7	5	3	12	4	10	6
9 ,,	12	4	11	9	8	9	13	10	5	12	1	12	9
10 ,,	13	4	13	9	12	14	17	12	5	13	1	13	11
11 ,,	13	1	14	7	10	11	15	7	4	9	0	11	9
Midt.	12	1	12	6	7	6	12	4	3	6	1	9	6

ARMAGH.*—Six Years
Lat. N. 54° 21′, Long. W. 6° 39′; Height, 207 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
10	12	5	2	8	7	4	4	0	6	10	5	3
9	7	1	3	3	2	1	2	3	12	7	2	1
9	0	3	6	1	2	8	7	8	18	4	2	4
11	6	9	9	4	5	10	11	12	21	1	2	8
13	7	8	9	4	5	10	12	12	19	0	5	9
13	8	7	3	0	4	7	9	8	17	0	6	7
8	6	4	3	3	0	4	5	2	12	2	4	3
3	2	1	7	6	3	0	0	5	3	8	1	2
6	2	5	9	7	3	1	2	8	3	13	6	5
11	5	8	10	4	2	1	4	11	6	15	10	7
14	10	8	9	2	1	1	4	10	8	16	11	8
8	6	6	5	0	0	1	4	8	6	7	2	4
1	2	0	2	1	2	1	3	5	1	2	7	0
5	8	6	3	4	5	1	0	0	3	9	13	5
6	12	10	9	7	7	2	2	4	3	13	13	7
3	12	12	13	10	10	6	6	7	4	13	11	9
1	9	10	13	11	10	6	6	8	1	10	7	8
3	1	4	12	10	8	6	5	6	7	7	3	4
6	3	2	7	6	4	2	1	1	14	6	1	0
8	6	6	2	1	0	4	5	5	16	5	2	4
8	7	9	7	8	7	11	10	6	18	5	5	8
9	7	9	10	9	11	13	11	6	16	5	6	9
9	6	9	11	8	12	14	9	4	14	4	8	8
7	3	7	11	7	10	13	5	1	12	4	8	7

FALMOUTH.*—Six Years.
Lat. N. 50° 9′, Long. W. 5° 4′; Height, 211 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	7	2	1	1	2	3	3	1	1	4	6	1
2 ,,	8	2	3	6	7	10	10	9	5	9	1	8	6
3 ,,	9	4	12	11	12	17	17	15	13	17	3	8	12
4 ,,	14	10	18	15	16	20	18	19	17	21	8	12	16
5 ,,	19	10	16	16	14	19	17	19	19	22	8	16	17
6 ,,	20	10	14	10	9	14	12	13	14	20	8	14	13
7 ,,	16	7	9	4	4	8	5	6	6	14	3	10	8
8 ,,	7	1	1	1	1	3	0	0	1	4	6	3	1
9 ,,	1	6	4	5	3	0	3	4	7	1	11	5	4
10 ,,	9	11	10	8	6	2	6	7	12	7	16	14	9
11 ,,	13	18	15	11	10	6	9	10	13	11	19	18	13
Noon	10	14	13	7	11	7	8	11	12	8	13	9	10
1 P.M.	3	5	8	5	8	7	7	10	8	3	3	4	5
2 ,,	10	4	0	1	5	6	6	9	4	1	4	10	0
3 ,,	7	10	5	4	1	5	3	5	1	3	8	10	3
4 ,,	3	10	8	6	1	3	0	2	4	3	9	6	4
5 ,,	1	7	7	7	3	1	2	1	4	1	7	2	3
6 ,,	7	2	2	4	4	2	2	3	3	7	5	3	1
7 ,,	11	3	2	0	2	3	0	0	1	11	3	7	3
8 ,,	14	4	6	8	3	5	4	5	8	12	3	10	6
9 ,,	16	4	8	10	10	13	10	8	8	14	2	12	9
10 ,,	16	3	10	10	10	14	11	9	8	16	3	13	10
11 ,,	15	0	8	10	7	11	9	6	4	14	7	12	7
Midt.	12	2	6	8	5	9	7	3	1	10	9	8	5

OXFORD.—Eighteen Years.
Lat. N. 51° 46′, Long. W. 1° 16′; Height, 212 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	4	2	3	4	4	3	3	2	1	1	5	2
5	0	2	2	0	0	1	2	6	3	3	1	2
9	5	6	5	2	2	4	4	9	8	7	3	5
13	7	9	6	2	2	3	5	11	10	9	6	7
15	8	9	3	1	1	1	3	10	10	10	7	6
13	5	6	1	4	5	3	0	7	7	7	5	3
11	2	1	6	7	10	6	4	2	1	2	0	2
4	9	4	10	10	13	8	7	3	5	4	6	6
2	13	8	12	10	13	9	9	9	8	8	11	9
6	13	11	12	8	11	8	8	10	9	9	11	10
7	7	10	8	5	6	5	6	9	7	6	5	7
5	0	5	2	1	0	2	2	6	0	0	1	2
1	9	2	5	5	6	2	3	2	6	6	8	4
2	16	9	11	10	12	6	9	5	11	10	13	10
3	17	13	16	15	15	10	13	9	12	12	14	12
0	14	14	19	17	17	11	15	10	10	8	11	12
4	8	11	16	16	16	11	14	9	5	4	6	9
7	2	5	11	13	12	7	10	3	1	1	1	5
10	3	2	4	7	8	1	4	3	7	6	3	1
11	7	8	3	1	1	1	4	8	10	9	5	5
10	8	11	8	7	4	5	9	11	12	10	6	8
8	9	11	11	11	9	9	12	11	11	9	7	10
5	9	10	11	11	10	9	12	8	9	7	6	9
3	7	6	8	8	8	7	8	4	6	5	6	6

* Greenwich mean time.

KEW*.—Six Years.
Lat. N. 51° 28′, Long. W. 0° 19′; Height, 34 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	11	6	2	7	5	4	4	3	1	5	6	3
2 "	2	10	2	2	3	2	1	1	0	3	2	6	0
3 "	4	1	4	6	2	2	3	5	5	8	3	8	4
4 "	9	5	6	8	4	1	3	7	9	11	7	10	7
5 "	14	6	7	7	1	2	1	6	9	10	8	13	7
6 "	13	6	3	0	4	6	4	2	2	8	6	10	3
7 "	10	3	2	5	8	10	8	3	4	2	2	7	1
8 "	3	4	8	10	10	12	10	7	10	4	6	2	7
9 "	2	8	11	10	8	11	9	8	14	6	10	8	9
10 "	8	10	11	10	7	9	7	7	12	6	15	15	10
11 "	9	13	10	8	4	6	6	6	10	4	13	12	9
Noon	2	6	6	2	1	2	2	2	6	2	6	3	3
1 P.M.	7	1	3	2	5	5	2	2	0	9	0	5	3
2 "	12	10	12	10	10	10	7	6	7	13	7	10	10
3 "	10	13	15	15	14	13	11	10	12	16	8	9	12
4 "	7	14	17	18	17	17	14	13	15	14	6	5	13
5 "	4	10	15	17	19	20	17	15	14	8	3	3	11
6 "	2	3	7	11	15	18	15	12	10	2	1	2	7
7 "	7	0	0	4	9	12	10	5	2	7	1	5	2
8 "	11	2	5	7	1	4	2	5	4	12	3	10	4
9 "	13	4	7	10	9	6	6	10	6	16	1	12	8
10 "	15	4	8	12	11	11	10	11	7	17	0	12	10
11 "	15	3	7	12	12	12	10	12	5	15	4	12	9
Midt.	14	2	6	10	10	10	9	8	2	14	8	9	7

GREENWICH.—Twenty Years.
Lat. N. 51° 28′, Long. 0°; Height, 159 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	1	8	2	7	4	5	4	3	6	5	2	3
3	2	4	2	4	0	1	1	2	2	2	0	0
5	6	3	5	1	3	2	4	6	4	2	1	4
9	9	6	7	2	4	3	7	10	7	6	4	6
12	9	6	7	0	2	2	6	11	8	7	7	6
13	9	4	2	3	1	0	1	6	7	7	7	4
10	4	1	3	5	5	4	3	0	2	3	4	0
3	3	5	7	7	9	8	8	6	6	4	2	5
4	8	9	11	8	9	9	11	11	9	9	10	9
10	11	11	12	7	9	8	11	12	10	12	16	11
11	13	10	10	5	7	7	8	9	8	10	14	9
2	8	7	6	1	3	4	4	6	1	2	3	4
6	1	0	1	3	1	0	0	1	8	6	7	3
9	8	7	4	7	5	3	4	4	12	11	11	7
5	11	12	11	12	9	7	9	9	14	11	9	10
2	11	15	13	14	12	11	11	11	14	10	7	11
2	8	14	14	16	15	14	14	12	10	6	5	10
5	2	10	12	15	14	14	13	9	3	2	2	8
8	3	4	7	10	11	11	9	2	2	1	1	3
9	5	1	1	3	5	5	0	4	6	2	3	2
9	8	5	7	6	6	4	6	7	10	5	4	6
8	9	6	9	9	9	7	9	9	11	4	5	8
7	9	6	9	10	10	8	10	7	10	4	6	8
3	3	10	5	11	7	8	7	7	9	9	1	7

LIVERPOOL.—Three Years.
Lat. N. 53° 25′, Long. W. 2° 59′; Height, 30 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	14	4	6	6	3	3	3	2	10	4	9	5
2 "	0	12	1	3	2	1	2	1	3	5	2	7	2
3 "	3	6	5	0	4	1	5	2	7	1	3	7	2
4 "	12	0	12	3	9	2	7	5	7	4	9	2	6
5 "	13	4	13	3	5	2	7	7	9	6	12	1	7
6 "	21	7	8	1	1	0	4	5	6	7	12	3	6
7 "	13	7	3	7	4	2	0	1	3	2	12	2	3
8 "	4	4	2	10	10	5	3	3	8	5	4	3	3
9 "	6	4	6	11	9	7	5	5	11	6	2	13	6
10 "	11	4	7	10	8	7	6	5	11	6	0	15	7
11 "	14	4	7	8	7	8	6	5	8	5	1	12	6
Noon	8	7	6	4	6	6	6	4	6	0	4	2	3
1 P.M.	3	9	2	0	4	4	5	2	5	9	5	9	1
2 "	0	13	5	7	1	2	1	0	1	11	7	16	5
3 "	0	14	12	15	5	3	0	4	7	14	7	16	8
4 "	2	13	12	19	9	8	4	7	9	14	5	13	9
5 "	3	7	12	20	13	12	8	10	10	11	1	10	9
6 "	2	1	6	18	13	13	8	11	9	4	6	7	7
7 "	4	4	1	12	11	11	7	8	5	1	10	4	3
8 "	4	7	7	2	7	9	3	0	1	5	12	2	1
9 "	3	11	9	6	1	2	3	4	6	8	14	1	5
10 "	3	16	10	10	2	1	6	8	5	10	13	1	7
11 "	3	19	13	15	5	2	8	9	6	9	12	0	8
Midt.	7	16	5	7	9	6	4	6	1	13	9	11	8

GELDESTON.—Four Years.
Lat. N. 52° 28′, Long. E. 1° 32′; Height, 38 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
9	12	4	1	4	0	1	7	6	5	2	4	1
9	12	0	2	7	6	4	2	1	8	0	4	3
9	15	7	6	11	9	8	3	5	13	5	6	7
5	18	10	9	14	10	7	7	9	15	10	9	9
2	15	11	8	11	8	5	6	11	15	10	12	9
2	14	9	3	6	5	2	3	9	14	9	14	7
5	9	5	2	2	1	3	1	5	8	6	10	3
10	2	1	6	3	2	7	3	1	1	1	3	2
18	4	5	10	5	6	8	6	4	6	7	6	7
21	8	8	12	7	7	7	6	4	10	9	13	9
20	11	9	10	6	8	7	5	3	10	10	13	10
10	8	7	8	4	7	5	4	1	5	2	7	6
1	2	3	4	2	5	2	3	2	1	3	2	1
8	3	2	0	1	3	0	0	4	2	8	6	2
9	5	8	6	3	1	4	3	7	4	8	5	5
11	6	11	8	5	2	7	6	8	3	6	3	6
11	3	10	10	6	4	10	8	7	0	2	2	6
10	3	5	8	6	5	10	8	3	6	1	1	4
9	7	2	5	2	4	7	5	3	8	3	5	0
9	9	6	0	5	1	4	1	8	10	5	7	3
9	12	9	3	11	5	2	4	11	11	6	9	6
9	13	9	3	13	6	5	4	11	10	7	9	7
10	14	8	2	13	4	6	3	9	8	7	8	6
14	16	7	1	12	2	4	1	7	7	6	5	4

* Greenwich Mean Time.

STONYHURST.*—Six Years.
Lat. N. 53° 51′, Long. W. 2° 28′; Height, 361 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	10	12	6	1	3	5	1	5	2	1	6	2	3
2 ,,	9	7	2	3	4	0	4	1	6	4	4	2	1
3 ,,	11	1	6	8	2	4	9	6	13	12	1	4	6
4 ,,	14	4	9	10	4	3	10	9	14	14	4	7	9
5 ,,	17	7	10	10	3	2	9	11	16	16	5	10	10
6 ,,	16	5	5	1	2	3	5	8	8	13	4	9	6
7 ,,	14	3	1	3	4	5	2	6	3	9	1	5	3
8 ,,	4	2	4	7	6	3	1	1	3	1	8	2	3
9 ,,	3	6	6	8	5	7	1	0	7	2	10	7	5
10 ,,	11	10	8	9	4	6	4	2	10	5	15	14	8
11 ,,	13	11	8	6	2	5	4	2	9	4	13	11	7
Noon	6	7	6	3	1	3	4	3	9	1	7	3	4
1 P.M.	4	3	1	1	4	2	2	0	3	5	1	5	2
2 ,,	6	10	7	5	7	5	1	2	0	7	6	10	5
3 ,,	6	13	11	13	12	10	2	5	6	11	9	10	9
4 ,,	2	12	12	15	13	13	4	6	7	8	6	6	9
5 ,,	1	9	11	16	15	15	7	10	7	3	3	5	8
6 ,,	6	2	4	10	12	12	6	7	1	5	1	0	4
7 ,,	10	1	1	4	7	8	2	2	5	9	0	2	0
8 ,,	14	3	6	7	1	2	4	8	10	13	0	5	6
9 ,,	14	4	7	11	8	6	10	11	10	15	1	6	8
10 ,,	15	5	9	13	11	11	11	13	9	16	2	8	10
11 ,,	14	3	7	13	10	11	10	11	6	15	7	7	8
Midt.	12	2	7	13	9	9	8	9	3	13	9	6	7

MAKERSTON.—Four Years.
Lat. N. 55° 35′, Long. W. 2° 39′; Height, 213 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	13	14	4	7	4	3	0	9	4	7	4	3
2 ,,	8	15	18	5	9	1	3	3	4	8	11	1	6
3 ,,	11	21	21	8	11	3	5	7	1	11	18	3	10
4 ,,	16	24	19	10	9	1	3	9	5	12	21	9	12
5 ,,	18	22	16	6	5	3	0	4	3	12	22	11	10
6 ,,	17	20	11	0	6	5	3	0	4	8	20	9	6
7 ,,	10	14	6	4	10	7	5	3	8	1	13	7	2
8 ,,	0	6	1	5	12	9	6	5	12	5	5	2	3
9 ,,	6	1	4	6	12	8	6	5	13	8	3	6	6
10 ,,	10	6	8	5	10	7	5	4	11	9	9	11	8
11 ,,	8	13	11	3	8	5	5	3	6	7	11	10	8
Noon	6	13	10	1	5	3	4	0	2	3	7	5	5
1 P.M.	0	11	6	2	2	0	2	2	4	1	5	2	1
2 ,,	4	6	4	8	2	2	2	4	10	2	5	6	2
3 ,,	0	4	2	11	8	5	7	7	14	5	2	5	5
4 ,,	2	5	1	12	11	9	10	9	16	4	3	4	5
5 ,,	4	9	4	10	12	12	13	11	14	1	5	2	4
6 ,,	6	14	7	6	9	11	11	7	10	3	9	0	1
7 ,,	8	19	13	1	2	6	8	2	4	7	10	1	3
8 ,,	9	22	15	9	3	4	4	5	1	10	12	2	7
9 ,,	9	22	15	13	7	1	1	9	2	11	12	4	9
10 ,,	8	22	16	15	8	1	3	12	3	9	11	5	9
11 ,,	6	10	15	14	8	1	4	12	1	7	10	4	8
Midt.	2	7	14	4	3	8	6	2	12	1	0	7	1

GLASGOW.*—Six Years.
Lat. N. 55° 53′, Long. W. 4° 18′; Height, 184 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	11	13	9	3	8	6	4	6	1	4	3	3	3
2 ,,	12	10	3	6	5	3	1	1	5	8	1	4	0
3 ,,	11	3	3	10	1	2	5	5	11	14	3	3	5
4 ,,	14	2	8	12	0	2	8	9	14	17	5	2	8
5 ,,	16	4	10	11	2	1	7	9	15	18	4	6	8
6 ,,	15	5	9	3	5	3	3	6	10	17	3	7	6
7 ,,	12	4	5	3	8	6	1	3	3	11	1	6	2
8 ,,	4	0	0	8	10	8	3	1	2	3	7	1	3
9 ,,	4	4	4	10	9	6	3	2	6	0	14	4	6
10 ,,	11	5	4	10	7	5	3	2	8	5	17	10	7
11 ,,	15	8	5	9	4	2	2	1	7	8	18	10	7
Noon	9	5	2	4	0	0	1	0	5	5	12	2	4
1 P.M.	2	3	2	1	3	3	1	2	3	1	5	5	1
2 ,,	3	10	7	4	5	6	2	4	0	3	3	10	5
3 ,,	5	16	11	10	12	10	5	6	4	5	6	13	9
4 ,,	2	15	11	13	15	14	8	7	7	5	7	11	10
5 ,,	1	11	9	12	16	16	9	9	6	1	7	8	9
6 ,,	4	3	1	9	14	13	6	7	2	7	4	4	4
7 ,,	7	0	4	3	11	10	4	2	4	10	5	0	1
8 ,,	10	3	8	5	3	3	2	7	9	12	5	4	4
9 ,,	12	5	11	9	2	3	8	9	10	13	6	6	7
10 ,,	11	6	11	11	6	9	12	11	9	14	7	8	8
11 ,,	9	6	11	12	6	9	11	9	8	12	9	7	8
Midt.	7	6	9	13	5	7	10	8	4	10	10	8	6

ABERDEEN.*—Six Years.
Lat. N 57° 10′, Long. W. 2° 6′; Height, 88 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	10	15	12	9	3	3	4	4	2	2	1	1	1
2 ,,	9	13	8	13	0	2	1	0	1	7	2	1	1
3 ,,	11	7	1	16	4	6	6	6	8	13	6	1	6
4 ,,	12	2	6	20	7	7	7	8	12	15	8	5	9
5 ,,	15	1	8	19	5	6	6	10	14	16	8	8	10
6 ,,	15	3	8	12	1	4	3	8	10	14	6	10	8
7 ,,	12	2	7	6	2	1	0	5	7	10	2	8	5
8 ,,	3	2	3	1	5	3	1	2	4	3	6	2	0
9 ,,	3	3	2	2	7	3	1	1	0	0	11	2	3
10 ,,	8	4	1	4	6	3	1	0	2	3	15	9	5
11 ,,	10	6	2	5	5	2	0	1	3	7	18	9	6
Noon	4	2	0	5	4	2	0	0	2	5	11	3	3
1 P.M.	2	5	4	5	2	1	2	2	0	1	5	3	0
2 ,,	4	12	8	3	0	0	3	2	2	2	0	7	3
3 ,,	4	15	11	1	4	3	6	4	5	5	3	6	6
4 ,,	1	14	11	2	6	6	7	6	5	4	2	4	6
5 ,,	1	11	7	2	9	7	8	6	3	1	1	3	5
6 ,,	5	5	0	1	7	6	5	3	3	5	0	1	1
7 ,,	8	1	5	7	4	3	1	2	9	9	0	1	3
8 ,,	12	2	9	14	1	1	5	9	14	10	1	3	7
9 ,,	12	3	10	15	5	7	10	12	13	11	4	5	8
10 ,,	13	5	10	14	5	9	13	13	13	11	5	6	9
11 ,,	12	7	9	13	5	8	11	11	10	8	9	7	8
Midt.	10	8	8	11	1	4	9	8	7	8	11	7	6

* Greenwich Mean Time.

CULLODEN.—THREE YEARS.
LAT. N. 57° 29′, LONG. W. 4° 8′; HEIGHT, 104 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	3	0	3	3	8	6	5	2	1	3	2	2
2 ,,	3	2	0	1	0	3	3	1	1	1	5	4	1
3 ,,	6	0	1	0	0	3	1	0	2	2	8	8	2
4 ,,	6	1	2	1	0	4	0	2	5	5	9	10	3
5 ,,	6	2	2	1	1	4	0	3	4	7	10	11	3
6 ,,	6	0	3	3	4	5	2	1	1	3	7	10	1
7 ,,	0	6	3	4	5	5	3	2	2	2	2	5	2
8 ,,	7	12	12	5	4	5	7	4	6	5	3	1	6
9 ,,	10	16	14	6	4	4	5	3	6	5	2	2	6
10 ,,	16	17	14	3	1	0	2	2	4	6	4	6	6
11 ,,	14	16	11	0	1	1	0	0	2	5	6	8	5
Noon	9	10	8	1	3	4	1	1	1	2	4	5	2
1 P.M.	5	4	4	3	5	7	2	2	1	2	0	1	1
2 ,,	3	0	1	6	7	7	4	3	3	4	0	1	3
3 ,,	3	5	8	10	9	8	5	5	5	6	0	3	5
4 ,,	5	7	10	13	10	11	8	7	6	6	2	5	6
5 ,,	4	5	7	9	10	11	9	6	4	1	5	7	4
6 ,,	7	1	3	4	5	6	4	2	1	1	8	10	0
7 ,,	5	4	1	0	0	3	1	2	2	2	8	7	1
8 ,,	5	3	0	3	4	3	1	3	2	4	8	8	3
9 ,,	1	4	2	5	6	6	4	5	4	3	6	5	3
10 ,,	1	6	1	7	9	6	4	5	3	3	5	3	3
11 ,,	1	6	3	8	10	7	5	5	4	3	5	1	4
Midt.	3	6	3	9	9	6	4	4	4	2	5	2	3

BEN NEVIS.—FOUR YEARS.
LAT. N. 56° 48′, LONG. W. 5° 8′; HEIGHT, 4406 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
6	5	1	3	1	1	1	2	1	1	8	7	1
1	1	4	8	8	6	7	8	6	8	2	4	4
0	5	8	12	11	12	15	13	11	14	3	2	9
4	12	10	16	15	14	17	17	16	17	11	4	13
7	13	12	20	20	17	21	19	22	20	15	10	16
9	14	9	17	15	15	18	17	19	20	14	12	15
8	11	7	15	11	11	14	12	13	13	14	13	12
2	7	2	9	7	7	10	8	7	6	7	9	7
2	5	1	4	4	3	6	3	2	1	4	5	3
4	1	3	0	1	1	3	1	2	7	2	0	1
4	4	4	5	5	2	1	3	4	9	2	1	4
1	6	6	8	8	5	5	7	7	10	1	1	5
6	0	4	9	10	7	8	9	9	8	3	6	4
10	1	4	11	15	9	13	13	11	8	3	3	5
10	2	2	10	12	7	14	11	7	5	1	3	4
5	2	1	7	10	8	12	8	4	5	0	0	4
4	1	4	2	5	6	8	4	2	2	0	1	1
0	2	1	3	3	5	6	4	2	5	3	3	3
3	6	2	4	3	6	5	4	5	8	8	3	5
7	10	5	9	7	7	9	8	10	11	12	10	8
10	9	6	10	8	10	10	9	9	9	14	12	9
9	8	6	7	8	11	9	9	8	8	12	12	9
12	7	5	4	6	6	5	5	6	5	11	10	7
10	5	3	3	2	4	1	0	3	1	11	9	4

BRUSSELS.—TEN YEARS.
LAT. N. 50° 51′, LONG. E. 4° 24′; HEIGHT, 186 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
*1 A.M.	1	5	3	2	1	0	1	2	4	2	1	2	1
2 ,,	2	3	6	3	2	5	5	4	1	1	2	4	3
*3 ,,	5	5	13	7	5	9	10	8	5	5	7	5	7
4 ,,	8	8	14	8	6	9	9	8	7	7	9	7	8
*5 ,,	11	9	11	6	1	5	4	5	5	7	9	8	7
6 ,,	12	8	9	1	3	1	1	2	3	6	8	7	5
*7 ,,	6	2	1	5	11	8	4	5	3	4	2	1	3
8 ,,	2	5	6	9	12	10	9	8	7	9	5	6	7
9 ,,	6	9	12	14	14	13	11	12	12	13	10	14	12
10 ,,	11	12	14	15	13	12	10	13	13	15	14	20	13
*11 ,,	7	10	11	12	10	9	8	8	9	12	7	10	9
Noon	2	6	10	5	6	6	5	4	4	4	2	7	5
*1 P.M.	7	2	2	1	2	1	0	1	2	4	5	4	2
2 ,,	10	10	4	5	5	4	3	5	6	11	10	6	7
3 ,,	7	12	8	12	11	7	6	8	11	13	9	5	9
4 ,,	5	13	12	15	14	11	10	11	14	15	10	5	11
*5 ,,	2	7	8	13	15	13	12	13	14	11	7	3	10
6 ,,	2	3	4	12	10	10	10	12	12	2	2	2	7
*7 ,,	6	2	3	4	7	6	7	5	3	1	2	0	2
8 ,,	9	5	8	3	3	2	0	2	3	4	5	1	3
9 ,,	3	6	10	7	4	6	8	6	6	8	7	1	6
10 ,,	7	6	10	7	6	9	10	8	7	5	5	1	7
11 ,,	5	7	8	8	7	11	11	10	7	5	5	0	7
Midt.	3	9	1	6	5	6	5	4	7	5	4	1	5

UTRECHT.—TEN YEARS.
LAT. N. 52° 5′, LONG. E. 5° 7′; HEIGHT, 44 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	6	4	5	2	2	5	7	0	1	3	4	3
1	9	10	10	2	8	11	9	6	6	7	5	7
2	11	14	12	4	9	13	11	11	9	10	8	10
6	11	13	10	2	8	11	10	11	7	8	10	9
7	9	10	6	2	5	7	7	8	3	6	9	6
4	2	3	0	5	1	2	2	4	4	0	4	1
2	3	3	5	8	3	1	4	2	12	8	4	4
5	7	7	7	9	5	4	7	5	15	11	9	8
10	11	8	9	8	5	5	9	7	16	13	9	9
8	11	8	9	7	6	5	8	5	15	10	10	9
3	10	7	5	3	4	5	6	4	9	5	2	5
4	2	2	2	1	3	4	4	1	2	2	4	1
8	4	2	2	5	0	2	1	4	5	4	10	3
9	7	4	6	8	2	0	1	6	9	9	11	6
6	7	5	8	11	4	2	4	9	11	8	8	7
6	7	7	9	13	7	4	6	7	11	6	7	8
2	2	2	7	13	7	4	6	4	8	2	5	5
0	2	3	2	9	4	2	3	2	4	1	2	2
2	4	6	5	3	0	3	1	8	1	2	1	3
4	6	8	9	2	4	7	4	9	1	4	4	5
6	9	9	11	5	8	8	5	8	2	6	4	7
5	7	6	11	6	9	10	6	9	2	5	5	7
2	6	2	8	6	7	7	5	8	1	4	4	5
5	2	1	0	3	4	3	3	4	2	1	2	2

* Hours Interpolated.

GRONINGEN.—TEN YEARS.
LAT. N. 53° 13′, LONG. E. 6° 34′; HEIGHT, 49 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	4	8	3	0	2	0	0	1	1	1	7	1
2 ,,	3	8	2	2	4	2	5	5	4	4	1	7	3
3 ,,	1	11	4	5	6	11	9	10	9	9	5	7	7
4 ,,	5	14	8	7	12	11	11	14	13	12	8	10	10
5 ,,	9	14	10	9	8	9	11	13	13	11	7	12	11
6 ,,	11	12	7	5	4	6	7	8	9	10	7	12	8
7 ,,	7	8	3	2	4	1	4	5	5	4	3	8	4
8 ,,	3	1	1	1	6	0	0	0	1	1	5	1	1
9 ,,	4	4	3	3	7	2	2	3	7	5	10	6	4
10 ,,	9	12	5	6	7	5	3	5	9	10	14	12	8
11 ,,	11	12	8	5	7	3	4	7	8	11	13	12	8
Noon	4	9	6	3	5	2	3	6	7	8	7	5	5
1 P.M.	3	0	0	1	2	0	0	6	4	1	2	1	1
2 ,,	8	2	6	6	2	3	1	4	0	4	7	5	3
3 ,,	7	5	8	8	5	4	0	1	3	7	9	3	5
4 ,,	5	4	9	10	8	5	1	0	6	7	8	1	5
5 ,,	3	2	8	8	9	6	3	2	8	4	5	2	5
6 ,,	1	2	2	5	8	4	3	2	3	2	2	3	2
7 ,,	2	7	3	0	3	1	1	2	3	6	1	6	2
8 ,,	4	9	8	8	3	4	6	3	8	7	2	8	6
9 ,,	5	9	7	10	7	10	10	5	9	8	3	8	8
10 ,,	5	10	6	11	8	13	11	7	8	7	2	8	8
11 ,,	4	8	2	10	9	16	8	5	6	7	1	8	6
Midt.	7	2	8	8	3	6	4	5	3	6	5	3	5

AMSTERDAM.—EIGHT YEARS.
LAT. N. 52° 22′, LONG. E. 4° 53′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	5	14	4	0	5	0	1	3	4	4	4	3
2 ,,	2	0	9	3	4	3	6	6	5	2	2	4	2
3 ,,	1	5	7	9	10	10	10	11	9	7	6	5	7
4 ,,	4	9	10	13	11	12	11	15	13	9	13	8	11
5 ,,	9	11	13	14	10	12	11	15	14	10	17	11	12
6 ,,	13	11	11	10	6	10	8	12	11	8	20	11	11
7 ,,	9	7	5	4	2	7	5	7	7	0	17	6	6
8 ,,	4	2	0	1	4	3	0	4	2	9	7	6	0
9 ,,	2	2	3	4	9	0	2	1	2	13	4	9	4
10 ,,	9	5	9	7	10	3	5	6	5	15	2	15	8
11 ,,	10	8	7	8	11	4	7	6	5	14	1	16	8
Noon	1	12	6	9	6	9	4	6	9	5	2	7	6
1 P.M.	7	6	2	4	5	8	6	6	7	2	2	0	3
2 ,,	10	3	3	1	3	6	5	5	6	4	5	4	0
3 ,,	9	7	9	3	2	4	1	2	1	7	4	4	3
4 ,,	5	7	9	5	5	2	1	1	2	8	0	2	3
5 ,,	4	6	8	7	9	1	2	2	3	6	3	3	4
6 ,,	0	2	3	5	8	2	2	2	1	0	7	2	2
7 ,,	4	1	2	1	4	2	4	0	1	3	12	1	1
8 ,,	8	3	7	6	0	3	0	5	6	6	14	2	5
9 ,,	10	7	9	9	5	9	5	8	8	8	14	3	8
10 ,,	11	6	11	9	6	11	9	8	8	7	15	3	9
11 ,,	11	7	19	9	8	12	9	8	7	7	13	4	10
Midt.	10	7	16	7	4	8	5	6	5	6	10	1	7

HELDER.—TEN YEARS.
LAT. N. 52° 57′, LONG. E. 4° 45′; HEIGHT, 14 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	2	0	3	6	4	5	5	0	1	2	9	3
2 ,,	2	4	5	9	10	11	11	10	7	5	5	8	7
3 ,,	8	10	11	14	14	17	15	15	13	11	11	9	12
4 ,,	13	14	14	18	16	18	16	19	17	13	16	11	16
5 ,,	14	15	14	17	13	17	14	18	15	13	19	13	15
6 ,,	11	14	11	13	8	13	11	14	9	11	19	8	13
7 ,,	6	9	7	11	1	7	5	9	7	4	15	4	7
8 ,,	4	5	1	4	1	4	3	6	4	2	10	2	2
9 ,,	9	4	4	3	7	0	3	0	4	7	2	14	4
10 ,,	9	7	8	7	11	3	6	5	7	10	2	20	8
11 ,,	1	11	10	8	12	4	9	7	7	10	1	18	8
Noon	7	8	10	7	11	4	8	7	7	5	1	12	6
1 P.M.	9	2	4	7	7	9	7	7	6	1	2	1	3
2 ,,	5	6	0	3	3	11	7	6	3	4	7	4	1
3 ,,	3	6	4	2	2	7	6	6	2	4	2	3	0
4 ,,	0	4	5	1	0	5	4	4	0	5	0	2	0
5 ,,	2	1	4	1	2	3	1	2	1	1	5	1	0
6 ,,	6	5	2	2	2	2	0	2	1	5	9	1	2
7 ,,	9	7	6	5	1	4	2	5	6	7	11	1	5
8 ,,	11	9	8	8	7	5	3	7	6	7	12	2	7
9 ,,	10	9	9	11	7	11	8	11	9	10	13	2	9
10 ,,	9	8	8	10	7	10	8	12	9	8	10	1	8
11 ,,	6	7	6	7	4	7	5	8	6	5	7	0	6
Midt.	2	5	3	3	0	7	2	2	3	3	4	4	2

KEITUM.—FOUR YEARS.
LAT. N. 54° 54′, LONG. E. 8° 22′; HEIGHT, 30 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	8	13	1	2	4	0	6	1	0	2	2	6	3
2 ,,	11	10	3	2	1	5	1	5	4	5	1	4	2
3 ,,	13	7	10	7	6	9	6	11	8	8	4	2	6
4 ,,	16	1	15	11	10	12	11	15	12	10	8	0	10
5 ,,	19	2	18	14	13	13	14	17	14	11	10	3	12
6 ,,	22	5	18	12	12	12	15	16	13	9	11	5	13
7 ,,	18	4	15	9	10	9	13	14	10	3	9	4	10
8 ,,	12	0	11	5	7	7	11	12	6	3	5	2	6
9 ,,	3	2	4	2	3	4	7	9	1	8	0	2	2
10 ,,	4	4	2	2	0	1	4	5	2	11	3	6	2
11 ,,	9	6	7	3	2	4	2	1	3	11	4	7	5
Noon	6	6	10	3	2	5	1	4	2	11	0	3	4
1 P.M.	2	1	7	1	3	7	3	6	2	8	4	3	3
2 ,,	2	6	4	0	2	7	5	9	1	5	10	6	1
3 ,,	3	10	1	4	2	7	6	8	0	2	11	8	1
4 ,,	1	10	2	6	2	5	6	7	1	2	10	6	2
5 ,,	5	8	3	6	1	2	5	5	1	2	7	4	1
6 ,,	8	4	0	4	1	2	4	4	2	0	3	3	0
7 ,,	11	1	7	2	2	2	6	6	5	1	0	3	3
8 ,,	15	0	10	11	5	3	7	10	10	2	3	2	6
9 ,,	15	1	12	15	10	7	11	12	12	1	7	2	8
10 ,,	16	1	11	16	11	8	13	13	13	0	10	2	9
11 ,,	15	2	9	16	10	7	11	12	11	2	9	3	8
Midt.	14	4	7	16	8	4	9	11	10	5	8	4	6

WUSTROW.—FOUR YEARS.
LAT. N. 54° 24′, LONG. E. 12° 24′; HEIGHT, 23 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	16	1	1	3	2	1	3	4	3	0	5	1
2 "	3	13	2	4	5	7	5	9	7	4	2	4	3
3 "	4	11	8	6	8	11	9	12	11	13	2	2	6
4 "	6	5	12	8	10	11	8	17	14	18	8	1	9
5 "	7	2	13	9	10	10	6	18	14	19	12	4	10
6 "	12	4	14	5	6	6	3	17	13	21	12	4	10
7 "	10	3	10	1	2	1	3	13	7	15	10	3	6
8 "	6	2	5	4	4	4	7	11	1	4	5	0	1
9 "	2	5	0	6	6	7	9	6	4	4	0	5	3
10 "	3	5	1	9	9	10	10	2	7	9	4	10	6
11 "	6	5	2	9	9	11	11	0	8	13	5	10	7
Noon	1	4	2	8	7	10	10	2	6	12	4	4	6
1 P.M.	5	3	1	4	5	7	5	2	4	6	1	3	2
2 "	9	10	5	1	2	5	4	2	1	2	6	10	2
3 "	4	10	4	1	2	4	3	3	2	2	5	10	2
4 "	2	9	4	4	5	1	2	4	2	0	4	6	2
5 "	0	9	3	6	8	1	2	5	2	2	2	3	2
6 "	1	8	0	5	8	3	4	5	1	5	2	2	1
7 "	4	3	6	0	7	4	6	7	4	9	4	2	1
8 "	7	3	12	2	3	4	4	10	10	10	5	1	4
9 "	9	2	14	6	3	1	3	15	10	9	9	1	6
10 "	11	2	15	7	4	2	4	18	9	6	12	2	7
11 "	12	1	15	6	5	1	5	17	9	4	13	1	7
Midt.	10	2	14	6	4	2	7	14	7	1	14	0	5

HAMBURG.—FOUR YEARS.
LAT. N. 53° 33′, LONG. E. 9° 59′; HEIGHT, 85 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	8	8	2	2	6	1	1	0	1	4	0	6	1
2 "	10	4	3	4	2	5	2	4	3	7	2	4	3
3 "	11	1	10	7	1	6	6	8	6	10	6	2	6
4 "	16	2	14	9	3	5	8	10	8	11	11	2	8
5 "	18	3	14	8	1	2	7	10	7	10	12	5	9
6 "	17	6	14	4	3	2	4	6	5	6	12	5	6
7 "	13	3	8	2	7	6	1	1	1	1	8	4	2
8 "	6	2	2	6	10	11	2	3	6	8	0	0	3
9 "	2	6	3	9	11	12	6	7	10	14	6	6	8
10 "	6	8	8	8	10	11	5	8	11	15	9	7	9
11 "	9	9	9	6	6	9	3	6	9	15	8	5	8
Noon	5	5	8	1	2	5	1	4	6	9	3	1	4
1 P.M.	0	2	3	2	3	2	1	1	0	2	2	3	0
2 "	2	9	1	8	8	2	3	2	5	3	7	6	5
3 "	3	10	4	12	13	5	4	6	9	7	7	5	7
4 "	1	10	7	15	15	10	6	8	12	9	6	4	8
5 "	4	7	8	14	16	13	8	9	12	7	2	3	8
6 "	7	3	3	10	13	13	8	9	8	2	1	3	5
7 "	10	0	4	2	7	10	6	5	1	2	6	1	1
8 "	12	2	9	8	1	6	2	4	6	3	6	2	4
9 "	14	2	12	12	8	1	4	9	7	4	9	3	7
10 "	14	2	13	14	9	3	6	10	8	2	9	4	8
11 "	15	1	10	15	10	4	7	10	8	3	8	2	7
Midt.	12	2	7	14	9	3	6	8	7	4	8	1	6

NEUFAHRWASSER.—FOUR YEARS.
LAT. N. 54° 24′, LONG. E. 18° 40′; HEIGHT, 15 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	18	1	1	0	3	0	1	1	9	1	10	3
2 "	7	14	3	4	2	3	6	6	3	6	2	9	2
3 "	9	10	6	7	6	8	10	9	6	13	6	6	5
4 "	11	4	9	10	8	10	15	12	9	16	9	2	9
5 "	14	1	10	12	7	10	11	11	9	18	10	4	10
6 "	12	3	10	8	2	6	9	8	4	16	9	6	8
7 "	12	4	8	4	1	2	4	4	1	14	6	8	5
8 "	6	2	2	0	5	0	2	1	6	5	0	4	1
9 "	3	1	1	1	6	3	0	2	10	0	2	0	2
10 "	0	0	1	2	7	5	1	5	11	2	4	2	3
11 "	1	2	2	2	6	5	4	6	10	3	4	0	4
Noon	1	1	3	0	5	6	3	7	6	2	2	4	3
1 P.M.	3	4	2	2	4	4	3	6	2	0	0	6	0
2 "	4	8	5	4	0	2	2	3	4	2	3	8	3
3 "	1	6	5	6	3	0	2	1	6	0	2	6	3
4 "	3	5	5	6	5	1	2	1	8	1	1	2	2
5 "	6	3	4	5	7	3	2	4	9	6	2	0	2
6 "	8	1	3	3	7	3	1	4	5	11	3	2	0
7 "	10	0	7	3	3	4	1	2	1	12	4	2	3
8 "	10	1	12	10	1	1	3	4	4	12	6	3	5
9 "	12	2	14	12	4	5	7	7	6	14	8	6	8
10 "	14	2	14	14	3	5	8	8	4	12	7	7	8
11 "	14	3	12	13	2	6	9	9	2	8	5	5	7
Midt.	14	4	9	11	1	3	6	8	2	6	3	3	5

LEIPSIG.—EIGHT YEARS.
LAT. N. 51° 20′, LONG. E. 12° 23′; HEIGHT, 390 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	7	6	3	2	1	3	0	3	0	9	4	2
2 "	4	5	2	1	4	3	1	2	1	2	8	5	0
3 "	3	0	2	2	4	5	2	4	2	5	4	7	3
4 "	5	4	5	4	5	4	2	5	3	7	1	8	4
5 "	7	4	6	3	2	1	1	3	4	8	2	14	4
6 "	9	5	5	2	5	6	6	2	0	7	4	15	2
7 "	6	2	0	8	10	11	10	6	5	1	1	13	2
8 "	0	3	5	12	15	14	13	11	11	6	4	7	7
9 "	7	7	9	16	17	16	15	13	17	11	8	0	11
10 "	13	10	11	18	17	15	15	14	18	13	10	6	13
11 "	15	12	10	15	16	14	13	12	16	12	8	6	12
Noon	9	9	8	10	11	11	9	9	12	7	0	2	8
1 P.M.	1	3	1	3	5	5	5	4	4	1	6	3	2
2 "	5	5	8	5	1	2	2	2	4	5	12	6	5
3 "	5	9	13	11	7	6	6	7	11	9	13	5	8
4 "	4	10	15	17	13	12	12	12	15	10	12	1	11
5 "	3	8	15	19	17	16	17	15	18	8	10	3	12
6 "	1	5	9	18	18	18	19	16	17	4	6	5	10
7 "	1	1	3	14	15	15	17	12	12	1	3	7	7
8 "	2	0	2	6	11	12	13	6	5	3	0	11	3
9 "	3	1	6	1	4	4	5	0	2	4	4	12	1
10 "	3	1	7	2	0	0	0	4	1	4	6	13	3
11 "	2	0	7	4	2	1	3	5	1	2	5	13	4
Midt.	1	1	6	4	3	0	4	6	2	1	6	12	4

HALLE.— ? YEARS.
LAT. N. 51° 30′, LONG. E. 11° 57′; HEIGHT, 362 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	2	2	3	1	3	5	1	2	6	2	3	1
2 ,,	4	5	5	5	4	0	2	4	5	8	6	7	4
3 ,,	6	8	7	6	5	2	0	5	7	8	8	10	6
4 ,,	7	8	6	5	4	0	0	5	6	5	8	12	5
5 ,,	7	8	4	3	1	4	3	2	3	1	6	11	3
6 ,,	5	4	0	2	5	8	4	4	1	5	5	7	1
7 ,,	3	0	3	8	10	13	8	9	7	11	1	3	5
8 ,,	2	5	5	13	13	16	10	13	13	16	3	2	9
9 ,,	4	8	6	14	13	16	10	16	17	21	8	7	12
10 ,,	8	9	9	15	13	14	9	16	16	23	12	13	14
11 ,,	8	8	8	13	11	11	5	8	13	20	8	10	10
Noon	3	6	5	8	8	7	2	9	9	2	2	2	5
1 P.M.	4	1	1	3	3	0	3	1	2	2	4	5	1
2 ,,	6	5	5	4	4	7	7	4	5	5	7	8	6
3 ,,	6	8	7	9	10	13	12	9	12	12	7	7	9
4 ,,	4	9	9	13	14	19	16	13	15	15	7	3	12
5 ,,	1	7	7	14	18	21	17	16	15	14	4	1	10
6 ,,	0	5	5	12	18	19	15	15	15	8	0	3	9
7 ,,	3	1	1	7	14	13	11	10	7	6	4	6	5
8 ,,	4	0	3	2	4	8	4	3	2	2	6	8	0
9 ,,	7	3	4	0	2	2	2	1	1	1	8	9	3
10 ,,	7	6	4	3	2	2	8	4	4	2	8	9	5
11 ,,	7	4	3	3	3	4	9	4	4	0	6	7	5
Midt.	3	2	1	0	2	4	8	2	2	3	2	2	2

MAGDEBURG.—FIVE YEARS.
LAT. N. 52° 9′, LONG. E. 11° 37′; HEIGHT, 177 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	1	8	1	4	5	6	3	4	0	2	0	3
1	0	4	2	4	2	3	2	2	2	1	0	1
1	4	1	5	3	0	0	0	0	7	4	0	2
8	5	4	6	2	1	0	0	3	7	7	3	3
10	4	4	2	7	5	2	0	3	7	7	6	2
10	3	2	4	11	10	6	4	2	5	6	6	1
4	2	3	9	17	13	10	9	8	0	2	4	5
5	6	8	15	17	15	14	12	13	6	6	2	10
12	11	11	17	17	15	14	14	17	9	9	5	13
18	14	12	17	16	13	14	15	18	11	12	10	14
19	14	10	11	11	10	12	13	13	10	11	8	12
6	8	4	7	6	5	7	7	8	5	3	1	6
6	0	4	1	4	2	1	1	2	3	4	7	2
11	9	12	6	10	9	6	6	6	9	9	10	9
11	12	18	13	15	15	10	11	12	12	10	9	12
7	13	18	18	19	19	14	14	16	13	9	7	14
4	11	16	19	22	23	17	18	16	8	7	3	14
1	5	10	15	20	23	18	17	14	1	3	0	10
5	1	1	8	15	17	14	11	6	4	1	3	5
8	2	4	1	7	11	8	3	1	6	2	7	0
10	5	8	6	5	0	1	3	3	11	5	9	5
13	8	10	7	9	4	3	6	4	13	5	11	8
13	8	10	9	13	7	5	7	5	13	6	11	9
10	8	7	7	13	7	5	6	5	11	4	10	8

BERGEN.—TWO AND ONE-SIXTH YEARS.
LAT. N. 60° 24′, LONG. E. 5° 20′; HEIGHT, 50 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	10	11	17	3	6	7	3	1	14	8	8	7
2 ,,	8	13	9	13	0	6	6	4	1	13	8	7	7
3 ,,	7	15	6	6	2	4	4	2	2	9	8	4	5
4 ,,	5	14	2	2	3	3	2	1	1	4	7	1	3
5 ,,	2	12	3	7	3	2	0	1	0	1	5	2	1
6 ,,	1	7	6	11	2	2	0	1	2	5	3	3	1
7 ,,	4	2	6	12	2	1	2	0	4	7	2	2	2
8 ,,	5	3	4	12	4	0	3	2	5	7	1	0	3
9 ,,	6	4	1	11	7	0	3	3	4	7	1	3	2
10 ,,	6	4	2	10	7	0	3	1	3	6	1	5	1
11 ,,	5	2	4	10	6	1	1	0	2	6	1	4	1
Noon	4	2	1	10	4	2	1	2	0	7	3	1	1
1 P.M.	4	3	3	9	2	1	3	5	0	10	6	4	3
2 ,,	3	7	8	7	1	1	4	5	1	12	9	8	5
3 ,,	2	12	12	6	3	4	5	3	1	13	11	11	6
4 ,,	2	15	13	4	4	7	6	0	1	12	12	11	7
5 ,,	1	17	11	2	6	9	6	2	0	8	10	9	7
6 ,,	1	14	6	1	6	10	6	3	2	3	7	5	5
7 ,,	0	9	1	3	6	8	6	2	3	3	4	2	3
8 ,,	0	3	4	7	5	5	5	0	4	7	0	2	1
9 ,,	1	2	7	11	2	1	2	2	4	11	2	4	3
10 ,,	2	5	9	15	0	3	1	3	4	13	4	6	5
11 ,,	4	7	11	19	2	6	5	2	2	14	6	7	7
Midt.	6	9	11	20	4	7	7	1	1	15	7	8	8

CHRISTIANIA.—THREE YEARS.
LAT. N. 59° 55′, LONG. E. 10° 44′; HEIGHT, 74 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	4	1	6	8	11	8	3	7	3	3	5	5
1	1	1	7	9	12	9	3	6	0	2	4	4
4	2	1	6	9	12	9	3	5	4	0	4	3
7	4	2	6	10	13	10	4	4	7	2	3	2
11	5	2	8	13	16	12	7	5	8	4	0	2
12	4	0	12	17	18	15	11	8	6	4	4	4
10	2	5	16	20	20	17	15	13	0	1	4	7
4	3	10	18	21	18	17	17	16	6	3	2	11
4	8	14	16	20	16	15	18	17	10	7	8	13
8	11	15	14	15	13	11	17	15	10	8	12	12
9	10	15	10	9	8	6	13	11	8	7	9	10
5	7	11	4	3	1	1	6	4	5	1	2	4
1	1	6	3	4	6	5	2	4	1	4	4	2
1	8	1	10	11	12	11	8	12	7	9	7	8
1	13	9	16	16	17	16	13	18	11	11	8	12
1	13	14	22	22	23	20	18	22	11	9	8	14
2	9	15	25	26	27	23	22	23	9	7	9	15
1	5	12	23	28	29	24	22	21	6	4	8	14
2	2	7	18	24	26	21	18	15	1	1	5	10
2	2	5	11	17	20	15	11	8	3	3	3	6
4	4	5	4	10	11	7	4	1	6	5	1	2
5	6	3	1	3	2	0	0	3	7	5	2	2
4	6	1	3	1	5	5	1	5	7	5	5	4
2	6	1	5	3	9	7	2	6	5	5	6	5

UPSALA.—FOURTEEN YEARS.
LAT. N. 62° 52′, LONG. E. 17° 38′; HEIGHT, 77 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	7	6	1	4	2	4	5	1	6	2	6	3
2 ,,	1	5	4	2	2	1	2	2	2	3	6	4	1
3 ,,	2	0	1	3	1	0	1	1	4	1	7	2	1
4 ,,	4	3	2	5	0	0	1	1	6	4	9	2	3
5 ,,	7	5	3	4	1	2	2	1	8	5	11	4	4
6 ,,	9	7	2	1	4	4	3	1	5	6	11	6	3
7 ,,	9	6	1	2	6	5	5	2	2	4	8	7	1
8 ,,	6	3	3	4	6	8	6	3	1	1	3	3	1
9 ,,	1	1	6	6	7	9	6	5	4	5	1	2	4
10 ,,	6	4	7	8	6	9	7	6	6	6	6	7	7
11 ,,	7	5	6	6	4	7	5	5	5	7	6	7	6
Noon	2	5	4	4	1	4	2	2	3	4	4	2	3
1 P.M.	2	1	0	1	2	2	1	1	0	0	0	1	0
2 ,,	2	2	5	2	4	2	4	5	3	4	2	4	3
3 ,,	2	5	8	6	8	6	9	7	6	7	2	4	6
4 ,,	1	4	10	9	9	8	11	9	7	7	0	2	6
5 ,,	1	2	9	11	11	11	12	11	7	6	2	2	7
6 ,,	2	1	5	9	11	13	9	10	4	2	3	1	5
7 ,,	2	3	1	4	7	11	5	7	1	1	5	1	2
8 ,,	2	2	2	3	2	7	2	1	5	2	6	0	1
9 ,,	4	1	2	4	2	1	2	3	7	4	7	1	3
10 ,,	6	2	2	5	4	2	4	5	7	4	7	2	4
11 ,,	7	2	3	6	4	2	6	6	7	3	7	3	5
Midt.	7	2	3	6	4	2	6	6	7	1	6	3	4

HELSINFORS.—TWO YEARS.
LAT. N. 60° 10′, LONG. E. 24° 5′; HEIGHT, 381 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
5	7	8	6	6	6	4	4	1	0	10	7	5
5	5	1	3	5	3	1	3	4	11	3	1	1
9	2	2	6	11	4	4	5	6	13	0	2	5
13	1	5	9	13	3	3	8	11	16	3	4	7
17	2	4	9	10	3	0	7	11	15	4	7	7
19	3	3	6	7	1	4	4	9	15	8	11	7
20	4	3	5	6	2	6	3	6	12	7	13	6
10	4	2	2	0	5	9	1	2	5	3	8	0
1	9	5	2	5	7	11	5	6	3	3	2	4
0	10	6	5	7	9	12	8	9	10	10	6	8
1	9	8	6	9	10	13	10	10	13	8	6	9
4	5	9	8	9	11	13	10	10	9	1	0	7
5	2	5	6	8	8	11	8	9	8	3	2	5
4	3	2	1	4	3	9	3	5	6	6	4	2
6	5	5	2	1	4	6	1	0	3	9	5	1
8	7	7	5	2	6	2	4	3	1	12	4	3
10	8	10	7	4	9	2	6	6	3	10	2	5
12	9	11	9	6	10	3	7	4	2	8	1	5
10	9	7	6	4	11	4	6	1	1	7	1	4
6	8	5	2	2	10	6	5	0	0	5	0	3
7	7	3	0	0	8	6	1	0	1	2	7	1
9	2	8	5	8	1	2	1	1	6	5	9	4
10	7	8	7	10	4	1	3	1	4	5	10	6
5	9	8	6	9	7	0	2	0	2	5	9	5

ST. PETERSBURG.—TWENTY YEARS.
LAT. N. 59° 56′, LONG. E. 30° 16′; HEIGHT, 15 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	4	2	0	1	0	0	1	1	0	2	2	1
2 ,,	3	3	1	2	2	0	0	1	0	2	0	2	0
3 ,,	1	0	2	4	3	0	1	1	2	5	2	1	2
4 ,,	1	2	4	6	3	1	1	2	4	7	4	2	3
5 ,,	3	4	5	6	3	0	1	2	5	9	6	4	4
6 ,,	5	6	6	5	1	0	0	1	4	10	7	6	4
7 ,,	7	7	5	3	1	2	1	0	3	9	7	7	4
8 ,,	7	7	2	2	3	3	2	1	1	6	5	7	2
9 ,,	4	5	0	1	6	5	4	3	2	2	2	4	0
10 ,,	2	0	2	4	7	7	5	4	4	3	2	2	4
11 ,,	4	4	4	6	7	7	5	5	6	6	5	5	5
Noon	3	4	5	6	7	7	5	6	5	6	4	3	5
1 P.M.	0	2	4	5	6	5	4	4	4	5	3	1	4
2 ,,	0	1	3	4	4	2	2	2	2	3	2	0	2
3 ,,	0	1	0	2	1	0	1	2	0	1	0	1	0
4 ,,	0	1	2	0	2	2	3	3	2	0	0	2	1
5 ,,	1	0	3	2	5	5	4	5	4	0	1	1	2
6 ,,	0	1	2	2	6	7	5	6	4	2	0	1	2
7 ,,	2	1	1	2	6	7	5	5	2	2	0	0	2
8 ,,	1	0	1	1	4	7	4	3	0	3	0	0	1
9 ,,	0	2	3	3	3	4	2	1	1	4	2	1	1
10 ,,	2	4	3	3	1	3	1	0	2	4	3	2	2
11 ,,	4	4	3	2	0	1	0	1	2	3	4	4	2
Midt.	4	4	3	1	0	0	1	2	2	2	4	3	2

MOSCOW.—FIVE YEARS.
LAT. N. 55° 46′, LONG. E. 37° 40′; HEIGHT, 513 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
3	2	2	2	4	1	0	3	0	4	1	6	2
3	1	1	2	2	2	0	3	1	3	0	4	1
2	0	2	2	1	2	0	3	2	1	1	4	0
1	2	5	2	0	2	0	2	2	1	3	3	1
3	3	8	1	1	2	3	0	4	0	4	1	2
5	5	9	2	3	2	4	1	4	0	3	1	2
3	5	11	1	2	4	6	1	2	2	2	1	1
1	4	9	4	0	6	9	3	1	1	0	2	1
2	1	3	5	4	8	10	5	2	0	1	3	3
2	2	0	7	4	7	9	4	3	1	2	8	4
2	2	2	7	4	7	7	4	4	1	2	7	4
0	3	2	5	4	6	6	3	4	2	1	3	3
3	1	1	3	3	4	4	1	5	2	5	2	1
6	0	0	0	1	0	1	2	3	4	6	2	1
6	4	0	3	2	2	0	3	1	5	5	3	3
5	3	0	7	6	7	5	4	3	6	4	0	4
2	0	0	11	7	10	9	7	4	7	1	4	4
0	1	0	12	10	11	11	8	5	3	4	2	4
1	2	5	9	11	10	10	7	2	0	5	1	3
0	3	9	4	2	8	9	3	2	2	4	1	1
4	4	10	1	2	4	7	0	2	3	4	2	1
5	2	9	0	4	2	4	2	1	5	3	2	2
6	2	7	1	6	0	2	2	1	5	3	1	2
5	2	3	1	6	0	0	3	2	5	3	3	2

LUGAN.—Five Years.
Lat. N. 48° 35′, Long. E. 39° 20′; Height, 203 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	2	2	2	2	2	2	3	4	6	6	6	4
2 ,,	4	4	3	2	0	0	0	2	2	5	6	6	3
3 ,,	4	4	3	0	4	4	3	4	2	2	5	4	0
4 ,,	1	2	1	4	9	11	8	8	7	3	2	2	4
5 ,,	3	1	2	9	15	14	13	14	13	7	2	3	8
6 ,,	7	4	5	14	19	18	17	19	18	11	7	7	12
7 ,,	9	5	7	17	22	19	19	22	21	14	10	11	15
8 ,,	10	5	7	17	20	19	17	22	21	15	12	13	15
9 ,,	9	4	6	15	17	15	15	19	22	14	12	13	13
10 ,,	6	2	4	11	13	10	11	15	15	13	11	11	10
11 ,,	3	1	2	7	7	5	7	10	10	9	8	8	6
Noon	0	2	0	2	2	2	2	4	4	4	5	5	2
1 P.M.	2	4	2	2	3	4	3	2	3	1	2	2	2
2 ,,	3	4	4	6	8	9	8	9	9	6	2	1	6
3 ,,	4	4	5	9	13	13	13	14	15	9	4	3	9
4 ,,	5	3	6	12	17	18	17	19	18	11	5	5	11
5 ,,	5	2	6	14	19	18	18	20	19	11	6	6	12
6 ,,	5	1	5	14	18	17	17	19	17	10	6	7	11
7 ,,	4	0	3	12	16	13	13	16	15	7	6	7	9
8 ,,	3	2	1	9	12	8	9	11	9	5	5	6	6
9 ,,	2	3	1	6	8	5	4	8	6	4	4	5	4
10 ,,	1	3	2	4	6	3	2	4	4	5	4	4	3
11 ,,	1	2	1	2	4	2	2	4	4	5	4	4	2
Midt.	2	0	0	2	3	3	2	4	4	6	5	5	3

ZLALOUSTE.—Twenty Years.
Lat. N. 55° 10′, Long. E. 59° 40′; Height, 1362 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
4	4	2	4	4	4	3	4	5	4	4	4	4
6	4	3	4	4	3	3	4	5	5	5	6	4
6	4	3	2	2	1	1	2	3	4	5	6	3
5	2	1	1	2	2	2	1	0	2	4	5	1
2	0	2	5	7	6	5	4	3	0	3	4	2
0	3	4	8	10	9	7	7	6	2	1	2	4
3	5	6	10	12	9	7	8	7	4	0	0	6
5	6	7	10	12	9	6	7	7	4	2	2	6
6	5	6	9	10	7	5	6	6	4	3	4	6
5	4	4	6	7	5	4	4	5	4	3	4	5
4	2	2	4	3	4	3	2	3	3	3	3	3
2	0	0	2	2	3	2	1	1	2	2	2	2
0	2	2	1	0	1	0	0	0	0	1	1	0
2	3	4	3	2	1	1	2	2	1	0	0	2
2	4	4	4	4	3	3	4	4	2	1	1	3
2	4	4	6	6	5	5	6	5	3	1	1	4
2	2	4	7	8	7	7	7	5	2	0	0	4
0	1	4	7	9	8	6	6	5	1	2	1	4
1	1	2	5	8	7	5	4	2	0	3	2	2
2	2	0	4	6	5	3	3	0	2	4	3	0
2	2	1	2	4	4	1	1	1	2	3	3	0
2	2	1	1	3	2	0	1	1	1	2	2	0
0	0	0	2	3	3	1	1	0	1	0	0	1
2	2	1	3	4	4	2	2	3	3	2	2	2

KAZAN.—Three Years.
Lat. N. 55° 47′, Long. E. 49° 8′; Height, 249 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	0	3	4	3	2	4	1	8	1	7	4	1	2
2 ,,	1	0	6	0	3	1	0	9	3	9	6	4	3
3 ,,	1	2	3	1	2	0	1	9	4	9	6	6	3
4 ,,	2	3	1	1	4	11	12	4	4	7	5	13	1
5 ,,	6	3	1	0	5	14	13	3	4	6	8	16	1
6 ,,	9	4	3	5	9	15	16	4	0	4	5	16	1
7 ,,	8	0	0	6	13	16	15	6	0	2	6	15	2
8 ,,	4	3	3	6	14	15	15	7	0	4	0	9	5
9 ,,	0	7	3	8	14	14	13	7	2	8	6	0	8
10 ,,	2	9	5	8	14	14	10	7	2	8	6	6	8
11 ,,	3	8	5	6	12	10	10	4	2	6	5	6	6
Noon	2	5	1	3	9	9	5	4	0	5	5	7	4
1 P.M.	7	4	1	1	6	1	1	4	2	1	3	0	1
2 ,,	7	1	3	2	1	3	6	4	0	2	1	2	1
3 ,,	3	5	6	8	6	8	12	2	2	2	4	6	3
4 ,,	1	4	9	11	12	15	18	3	4	2	4	11	5
5 ,,	5	2	8	14	17	17	19	4	2	2	6	9	5
6 ,,	8	2	7	14	19	18	19	3	2	6	3	9	5
7 ,,	8	2	3	8	18	15	14	0	2	6	5	7	3
8 ,,	8	0	1	1	11	12	10	1	5	7	2	4	1
9 ,,	5	2	2	2	7	7	6	0	6	6	0	4	0
10 ,,	5	2	6	3	3	4	1	1	5	1	0	3	1
11 ,,	2	2	6	3	1	4	1	3	4	3	2	2	0
Midt.	1	3	4	5	0	6	0	4	2	6	2	0	1

CATHERINENBURG.—Twenty-Two Years.
Lat. N. 56° 49′, Long. E. 60° 35′; Height, 896 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0	2	4	5	4	7	3	3	2	2	2	0	3
0	1	2	4	3	6	2	2	1	0	0	0	2
0	0	1	4	3	5	2	0	0	2	1	0	1
1	1	0	4	4	5	3	0	0	4	3	1	1
3	2	0	4	4	5	4	0	1	4	4	3	0
4	2	0	4	6	6	5	1	1	5	5	4	0
4	2	0	4	8	7	7	2	1	4	5	4	1
3	0	1	5	9	7	7	3	2	2	3	2	2
1	0	3	5	9	5	6	4	4	0	3	1	3
0	0	3	4	7	3	5	2	3	0	2	0	2
0	0	2	2	3	0	3	0	1	0	2	1	1
1	1	2	2	1	2	1	2	2	2	3	3	2
4	5	5	4	3	4	1	3	3	3	5	5	4
5	7	7	7	6	6	4	5	4	4	5	6	6
4	8	8	9	9	9	6	6	6	6	4	4	7
0	6	9	11	12	11	9	7	8	5	0	0	6
4	3	9	13	14	13	11	9	7	1	4	4	6
5	3	6	12	14	13	11	7	5	4	6	6	5
5	5	0	7	12	11	9	4	1	6	7	5	1
5	6	4	1	6	6	6	1	4	7	7	5	2
4	6	6	4	0	0	0	6	6	8	6	4	4
3	6	7	6	4	5	3	7	6	7	5	4	5
2	5	6	6	5	7	4	7	5	5	5	3	5
1	3	5	6	4	7	4	5	4	3	4	2	4

BARNAUL.—Twenty-two Years.
Lat. N. 53° 20′, Long. E. 83° 47′; Height, 459 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	5	4	6	5	0	2	4	4	4	0	5	4
2 ,,	5	6	6	7	6	2	3	5	6	6	2	5	5
3 ,,	5	7	6	7	6	1	4	5	5	7	4	5	5
4 ,,	7	6	4	7	3	0	3	6	4	5	7	4	5
5 ,,	7	4	2	3	0	2	0	3	1	4	7	3	3
6 ,,	7	1	0	0	5	5	2	1	2	1	6	1	0
7 ,,	5	0	4	3	8	6	4	2	6	0	5	1	2
8 ,,	2	3	7	5	11	8	6	6	9	5	2	3	5
9 ,,	2	7	9	7	13	8	7	9	14	9	1	6	8
10 ,,	5	8	10	9	14	9	8	10	16	12	4	9	10
11 ,,	5	6	9	9	13	8	8	9	14	11	3	7	9
Noon	2	4	6	6	9	4	6	6	8	7	0	4	5
1 P.M.	0	1	2	3	6	0	3	2	3	2	4	0	2
2 ,,	1	2	1	1	2	4	1	2	2	3	4	1	1
3 ,,	1	2	3	1	3	6	4	4	6	6	4	0	3
4 ,,	4	1	4	2	6	8	5	4	7	6	1	0	3
5 ,,	7	0	4	2	8	9	6	4	8	5	4	3	3
6 ,,	7	2	2	2	9	8	5	3	7	3	7	2	2
7 ,,	6	2	2	2	8	8	4	3	5	0	7	2	1
8 ,,	6	2	1	1	6	6	3	1	3	1	7	0	0
9 ,,	4	1	1	0	5	4	2	0	2	2	7	2	0
10 ,,	2	0	2	2	4	2	1	1	2	2	6	3	0
11 ,,	1	1	2	4	3	0	0	0	2	0	4	4	1
Midt.	4	4	3	4	5	0	1	2	3	2	1	4	3

NUKUSS.—One Year.
Lat. N. 42° 27′, Long. E. 59° 37′; Height, 216 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
5	4	10	5	11	3	13	19	14	7	4	11	7
11	4	9	2	16	2	15	19	16	8	4	6	8
6	7	14	2	13	1	14	17	15	12	5	6	8
4	11	13	3	11	3	7	14	10	10	6	13	8
10	5	11	3	2	11	0	5	2	6	4	13	5
6	1	5	7	8	20	9	9	10	1	1	9	4
1	7	2	19	18	26	18	20	21	10	9	1	13
8	17	15	22	24	32	25	27	31	22	24	13	22
21	23	20	25	24	31	25	31	37	28	28	24	26
23	25	20	30	25	29	23	30	37	28	32	31	28
16	26	19	24	22	24	21	23	26	22	22	22	22
5	11	11	8	9	13	13	15	17	11	5	7	10
15	5	2	0	1	2	5	8	5	6	10	9	2
17	16	14	10	8	8	3	2	8	13	20	16	11
14	19	17	26	19	17	12	12	18	16	19	15	17
12	18	17	25	21	24	18	19	22	17	17	13	19
10	18	13	24	26	32	23	22	22	16	13	7	19
3	9	6	24	25	30	19	24	22	11	7	1	15
4	1	2	20	16	25	12	15	14	3	5	4	8
3	6	8	4	6	18	7	3	4	1	1	6	2
1	4	11	2	7	6	2	4	1	4	1	6	3
1	4	11	2	12	6	3	4	1	4	1	4	3
0	1	10	1	12	10	1	2	4	4	1	3	1
1	3	3	4	13	16	4	3	7	5	4	2	3

TIFLIS.—Ten Years.
Lat. N. 41° 43′, Long. E. 44° 47′; Height, 1343 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	9	13	16	14	15	15	14	16	15	8	10	13
2 ,,	10	9	12	15	13	14	15	15	14	13	10	9	12
3 ,,	10	6	8	14	15	15	15	16	15	10	7	9	12
4 ,,	4	3	7	12	16	18	19	18	15	12	10	9	12
5 ,,	0	2	9	15	20	21	24	22	17	13	5	1	12
6 ,,	1	3	12	21	24	25	26	28	22	14	5	3	15
7 ,,	7	7	18	27	27	27	30	31	27	20	11	9	20
8 ,,	15	16	22	28	28	26	31	37	23	23	18	14	24
9 ,,	22	20	25	27	24	22	26	32	30	27	20	22	25
10 ,,	23	20	21	21	19	15	20	20	26	22	19	24	21
11 ,,	16	4	11	9	8	11	10	13	14	13	12	14	11
Noon	1	2	1	6	4	6	2	2	4	5	2	6	3
1 P.M.	18	18	15	18	17	20	15	16	18	24	19	21	17
2 ,,	27	27	29	30	30	36	27	30	34	37	28	28	30
3 ,,	26	28	34	41	39	39	38	43	44	41	31	27	36
4 ,,	24	28	38	45	43	43	46	49	48	41	29	23	38
5 ,,	19	24	36	43	44	43	53	50	46	37	24	18	36
6 ,,	12	15	26	37	38	34	43	45	38	25	15	12	28
7 ,,	4	4	13	24	26	24	31	30	23	12	6	4	17
8 ,,	0	3	1	6	11	10	15	11	6	8	2	1	6
9 ,,	4	7	7	5	5	6	2	3	4	7	3	4	5
10 ,,	5	9	11	10	11	12	10	8	9	11	6	7	9
11 ,,	6	11	12	9	14	16	13	12	13	12	13	9	11
Midt.	5	10	12	17	15	16	15	14	15	12	9	7	12

NERTCHINSK.—Ten Years.
Lat. N. 51° 19′, Long. E. 119° 36′; Height, 2080 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	5	3	11	5	6	4	2	4	1	4	1	4
2	4	2	10	6	9	3	2	5	1	4	1	4
1	2	1	8	7	12	5	3	5	2	1	1	3
2	1	2	7	10	16	8	5	6	1	2	3	4
3	1	4	8	14	22	8	10	10	2	4	6	5
2	0	8	15	18	26	17	17	12	5	4	4	9
1	5	15	22	22	29	20	20	20	10	0	5	13
6	10	21	23	22	29	20	20	23	16	6	1	16
11	14	22	21	17	24	17	19	23	19	9	12	17
13	16	20	16	11	18	14	15	18	16	11	10	15
8	8	14	12	5	11	7	8	10	8	5	4	8
3	3	4	4	3	1	0	0	1	4	4	5	2
10	13	9	16	12	11	6	7	10	11	11	7	10
14	19	17	26	20	22	12	14	19	12	14	9	17
14	21	22	34	26	30	18	20	22	17	13	6	20
11	21	26	36	28	37	20	22	27	14	10	2	21
7	17	24	35	27	37	26	21	25	9	6	2	19
1	8	16	31	21	30	18	18	20	4	2	6	13
4	8	7	10	15	23	16	15	12	1	5	4	7
6	12	0	2	5	16	10	7	5	1	6	5	1
7	13	3	8	3	7	3	2	1	3	7	4	3
6	11	4	10	6	3	1	2	2	3	6	3	4
4	8	4	11	6	1	2	2	3	2	5	1	4
1	6	4	12	6	4	2	2	2	1	3	2	3

SYDNEY.—FIVE YEARS.
LAT. S. 35° 51′, LONG. E. 151° 11′; HEIGHT, 155 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	0	2	4	7	0	6	10	9	5	2	10	3
2 „	14	12	12	13	2	4	2	3	3	5	7	0	6
3 „	18	19	19	19	6	8	5	5	12	7	13	4	11
4 „	15	20	19	19	9	10	7	8	13	5	13	0	12
5 „	2	15	13	15	6	9	6	6	4	2	5	1	7
6 „	13	3	1	5	4	3	0	5	8	16	8	22	5
7 „	23	11	13	10	14	14	14	17	23	26	19	31	18
8 „	28	20	24	25	27	26	27	30	30	31	24	34	27
9 „	33	29	32	30	30	28	32	34	34	33	24	30	31
10 „	27	24	27	26	23	25	30	27	24	27	14	22	15
11 „	20	15	17	16	6	10	18	13	10	13	3	8	12
Noon	10	6	4	3	11	7	4	12	8	5	19	5	5
1 P.M.	4	6	13	20	24	29	29	34	29	25	31	16	22
2 „	15	17	26	32	35	39	42	50	43	45	40	29	34
3 „	25	26	34	37	37	40	42	55	54	56	47	40	41
4 „	34	34	35	36	32	36	39	53	54	55	46	44	42
5 „	33	33	30	31	23	27	30	43	44	45	39	41	35
6 „	22	23	22	19	9	14	16	25	28	30	24	25	21
7 „	8	6	9	5	7	2	4	8	8	12	6	8	6
8 „	4	7	4	5	15	8	6	7	7	4	8	7	7
9 „	14	16	14	10	19	14	12	14	16	14	18	22	15
10 „	19	18	17	13	20	14	16	16	22	18	22	27	19
11 „	18	15	14	8	17	13	18	18	20	17	19	26	17
Midt.	12	9	6	4	14	6	15	15	16	14	12	20	13

MELBOURNE.—FIVE YEARS.
LAT. S. 37° 50′, LONG. E. 144° 59′; HEIGHT, 121 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	0	1	4	6	2	2	6	4	10	1	5	1	1
2 „	10	9	11	1	2	1	7	1	0	8	13	11	6
3 „	14	13	16	10	8	6	14	9	10	12	16	14	11
4 „	12	12	16	11	10	10	15	13	10	13	13	9	11
5 „	1	3	9	4	7	8	14	7	3	3	2	2	5
6 „	11	8	6	2	2	2	6	1	8	11	8	10	5
7 „	21	18	21	14	7	7	7	14	21	24	21	20	17
8 „	25	24	30	26	19	17	17	24	28	29	30	25	25
9 „	24	28	34	31	26	27	26	30	30	32	23	22	28
10 „	20	25	31	26	24	31	30	29	25	25	19	19	26
11 „	15	17	20	19	16	22	23	21	12	13	8	12	17
Noon	3	5	1	2	3	1	2	3	2	1	3	2	1
1 P.M.	7	6	9	17	19	18	15	16	20	10	13	10	13
2 „	19	19	22	28	28	25	25	28	30	24	25	22	24
3 „	28	29	30	31	20	29	24	30	31	37	32	33	30
4 „	36	35	34	32	24	24	21	31	38	35	33	38	31
5 „	36	34	28	27	18	17	14	24	30	30	30	37	27
6 „	27	23	17	14	6	8	5	12	17	18	15	20	14
7 „	8	6	5	0	7	1	5	1	4	3	1	5	1
8 „	5	8	9	8	10	8	11	7	5	12	13	6	9
9 „	19	18	16	14	15	13	14	12	13	16	22	18	16
10 „	19	16	19	15	15	13	14	12	13	13	21	21	16
11 „	19	16	14	9	10	13	12	4	9	10	18	18	13
Midt.	10	8	2	9	8	4	1	8	12	6	7	10	8

HOBART TOWN.—SIX YEARS.
LAT. S. 42° 52′, LONG. E. 147° 21′; HEIGHT, 37 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	14	12	1	4	4	14	17	3	5	8	2	3
2 „	9	1	7	4	4	11	8	1	3	7	3	5	2
3 „	14	3	2	6	9	10	12	6	5	5	4	2	7
4 „	18	6	2	2	16	11	18	8	6	9	1	8	9
5 „	2	3	0	7	11	7	20	5	3	1	1	2	3
6 „	6	13	10	5	7	7	8	6	5	9	12	11	5
7 „	17	22	22	14	5	7	1	11	15	16	19	16	14
8 „	21	29	27	26	15	11	10	21	22	20	16	16	20
9 „	15	24	27	29	20	19	16	26	27	19	10	8	20
10 „	8	16	26	22	19	23	19	22	14	9	0	1	15
11 „	0	2	5	12	11	12	9	15	1	5	13	8	3
Noon	8	8	4	3	3	5	6	9	13	16	22	12	8
1 P.M.	23	20	19	26	17	19	23	26	30	27	26	21	23
2 „	22	27	31	32	21	27	30	33	35	31	38	26	29
3 „	25	33	37	32	22	22	26	32	35	32	37	27	30
4 „	28	35	36	31	17	16	22	30	32	28	31	29	28
5 „	25	30	31	24	10	11	17	24	22	18	26	22	22
6 „	11	21	20	13	0	3	4	11	8	4	11	10	9
7 „	8	5	5	3	6	9	4	2	7	15	2	4	4
8 „	21	9	10	9	13	13	9	9	20	30	18	21	15
9 „	23	17	11	14	17	17	13	19	22	27	33	24	20
10 „	25	13	13	13	18	17	15	18	24	25	28	22	19
11 „	19	11	10	6	14	17	19	12	18	23	23	19	16
Midt.	4	12	16	11	1	2	5	17	10	7	24	15	10

CAPE TOWN.—FIVE YEARS.
LAT. S. 33° 56′, LONG. E. 18° 27′; HEIGHT, 37 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	1	4	7	17	12	9	9	8	4	4	0	6
2 „	4	8	15	18	28	22	22	22	18	16	13	9	16
3 „	13	16	23	19	28	23	23	24	24	24	19	17	21
4 „	20	21	24	16	23	18	21	24	23	23	21	23	21
5 „	21	22	21	15	17	12	17	16	17	16	18	23	18
6 „	11	16	15	9	9	4	8	7	10	9	8	14	10
7 „	1	4	9	0	1	4	2	2	2	0	4	2	0
8 „	10	7	4	7	6	9	4	8	9	16	14	8	9
9 „	18	16	10	9	9	11	7	12	12	19	20	18	13
10 „	21	17	8	12	10	14	8	12	10	15	19	23	14
11 „	17	13	4	8	7	11	6	7	4	14	16	18	11
Noon	9	8	4	3	4	3	2	5	1	8	6	9	6
1 P.M.	3	1	1	3	2	7	0	0	0	5	7	5	2
2 „	16	10	5	6	1	8	4	6	12	16	15	15	10
3 „	24	19	12	18	7	10	8	12	18	20	20	20	16
4 „	23	21	14	21	11	17	13	15	18	19	20	18	18
5 „	14	15	9	14	11	16	12	14	10	10	10	10	12
6 „	3	3	1	6	4	12	4	4	2	4	2	1	2
7 „	9	9	12	4	6	5	7	8	14	14	11	12	9
8 „	13	16	20	18	19	13	16	19	22	18	16	16	17
9 „	14	20	25	26	29	25	27	26	27	22	16	15	23
10 „	14	22	28	26	31	31	33	27	27	22	16	14	24
11 „	13	16	21	21	25	28	25	22	21	10	11	14	19
Midt.	9	9	10	9	6	6	8	6	10	3	3	7	7

LIBYAN DESERT.

	Regenfeld. Jan. 28–Feb. 5.	Sineh. Feb. 21–25.	Einsiedel. Jan. 19, 20, 23, 24.	Dachel. Jan. 9–13.	Bir-Kerani & Farafrah. Dec. 28, 29, 30–Jan. 2.	Average.
1 A.M.	...	...	...	...	...	...
2 ,,	11	11	19	9	19	13
3 ,,	...	...	...	...	...	...
4 ,,	21	6	26	14	8	16
5 ,,	...	...	...	...	...	...
6 ,,	9	17	24	4	11	1
7 ,,	...	...	...	...	...	...
8 ,,	25	53	13	41	37	32
9 ,,	...	...	...	...	...	...
10 ,,	47	47	48	50	48	48
11 ,,	...	...	...	...	...	...
Noon	19	23	21	7	23	19
1 P.M.	...	...	...	...	...	...
2 ,,	19	17	13	38	10	19
3 ,,	...	...	...	...	...	...
4 ,,	27	39	17	40	30	30
5 ,,	...	...	...	...	...	...
6 ,,	17	40	9	25	29	23
7 ,,	...	...	...	...	...	...
8 ,,	3	24	15	3	13	5
9 ,,	...	...	...	...	...	...
10 ,,	10	3	12	17	2	7
11 ,,	...	...	...	...	...	...
Midt.	6	2	0	7	7	2

TORONTO.—Six Years.
Lat. N. 43° 39′, Long. W. 79° 2′; Height, 342 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	12	3	20	5	11	5	9	11	3	0	8	7
7	10	4	21	7	12	6	12	11	1	3	2	6
5	10	9	20	5	11	6	12	11	1	2	2	7
1	9	9	19	3	5	2	9	7	1	2	8	6
5	7	2	11	9	8	9	3	1	5	0	9	0
1	0	4	16	17	18	14	13	18	1	4	6	9
4	11	15	28	24	25	21	21	25	14	12	11	18
16	24	21	35	27	28	25	25	27	21	21	22	24
23	30	23	36	25	27	25	28	31	23	22	26	27
25	29	22	35	25	26	24	29	29	21	26	30	26
15	25	16	28	18	21	20	24	22	16	16	16	21
8	9	8	17	8	13	13	16	12	3	0	3	7
22	8	6	9	2	3	4	8	2	10	11	15	4
25	18	18	3	10	5	5	3	11	18	18	22	13
19	18	22	13	19	12	13	14	19	20	16	18	17
14	18	22	17	25	19	19	18	22	20	14	11	18
8	14	17	15	27	24	25	21	22	16	10	9	16
0	7	13	15	25	24	22	20	21	11	5	3	14
4	0	7	14	21	21	20	19	15	7	4	1	10
5	2	0	5	12	17	15	10	6	3	4	0	5
5	4	5	4	3	6	3	5	5	0	4	2	2
3	3	4	7	0	4	1	5	4	2	5	2	1
1	0	4	9	1	2	1	3	5	0	8	3	1
0	12	3	13	3	9	3	5	10	0	0	6	5

BLUE HILL, MASS.—One Year.
Lat. N. 42° 13′, Long. W. 71° 7′; Height, 640 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	14	8	0	0	2	1	1	5	1	7	3	7	4
2 ,,	12	7	5	6	1	5	4	10	5	11	3	4	6
3 ,,	13	12	9	10	6	7	10	14	7	13	11	10	10
4 ,,	16	8	7	3	4	3	1	12	6	6	8	17	8
5 ,,	13	0	1	0	5	4	3	4	3	1	5	13	2
6 ,,	3	8	9	12	12	11	9	4	17	6	3	5	7
7 ,,	7	21	18	22	16	19	18	14	23	18	15	4	16
8 ,,	15	24	23	24	18	21	19	18	31	26	24	13	21
9 ,,	32	38	26	29	17	19	16	23	34	28	28	25	26
10 ,,	36	39	22	26	16	17	16	22	29	26	28	28	25
11 ,,	21	33	17	18	9	14	9	15	20	21	14	9	16
Noon	2	12	7	8	1	7	3	7	9	3	5	10	4
1 P.M.	16	5	10	2	11	4	5	1	5	10	15	20	9
2 ,,	21	18	25	14	18	11	13	8	13	16	26	23	17
3 ,,	19	22	30	25	24	18	18	15	21	18	21	11	20
4 ,,	8	34	27	30	25	20	23	18	23	20	14	5	21
5 ,,	7	18	22	28	25	21	26	17	21	14	8	1	17
6 ,,	1	12	15	23	12	18	24	13	18	5	0	7	11
7 ,,	9	6	3	12	6	12	17	9	11	3	2	10	5
8 ,,	11	6	3	2	4	6	11	0	6	0	4	12	0
9 ,,	11	5	7	6	12	2	4	1	3	4	3	10	4
10 ,,	9	5	9	5	10	1	3	1	2	1	6	10	4
11 ,,	5	7	6	7	8	3	1	3	5	4	3	12	2
Midt.	7	5	2	8	7	1	6	5	0	5	2	1	0

PHILADELPHIA.—Three Years.
Lat. N. 39° 39′, Long. W. 75° 11′; Height, 112 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1	7	2	1	3	7	1	1	5	7	7	11	1
7	3	1	6	7	10	4	4	10	11	11	16	3
8	2	9	5	7	7	3	5	9	11	7	14	4
3	3	9	2	3	2	0	4	5	7	3	10	4
3	0	2	7	6	7	10	5	6	3	6	8	5
9	4	11	20	19	22	19	17	16	12	12	15	15
21	13	20	29	26	24	25	23	23	21	19	23	22
32	23	28	34	31	29	28	26	29	30	28	29	29
40	26	28	35	28	27	27	33	31	29	34	30	31
41	26	25	33	24	25	26	30	29	26	38	32	30
23	19	16	23	18	19	19	22	21	14	17	11	18
6	4	2	8	6	10	12	12	9	1	6	5	4
28	17	14	6	5	0	0	0	5	6	23	24	11
37	32	31	21	17	11	11	12	20	28	33	34	24
34	34	34	31	28	19	20	22	24	28	33	34	29
31	32	34	42	32	27	27	27	30	28	27	30	31
24	24	25	36	34	30	28	29	27	21	18	26	27
15	14	16	31	27	23	28	28	23	12	5	21	20
3	6	7	22	16	18	21	18	16	1	2	18	12
3	0	3	9	2	10	14	8	7	9	6	13	4
2	8	10	1	10	0	3	3	1	13	7	12	3
3	12	11	3	18	3	4	1	5	16	10	8	6
2	11	7	10	19	5	2	2	4	9	3	5	6
2	9	7	4	2	3	7	3	2	7	3	10	2

WASHINGTON.—Eight Years.
Lat. N. 38° 56′, Long. W. 76° 58′; Height, 103 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	6	3	7	5	6	2	10	3	1	4	3	2	3
2 ,,	5	1	3	6	7	4	14	4	2	5	4	2	4
3 ,,	5	2	6	6	3	2	12	3	1	5	4	3	4
4 ,,	8	5	1	4	4	2	6	1	3	3	3	6	2
5 ,,	9	3	6	1	11	9	3	8	9	2	2	7	2
6 ,,	2	3	15	11	19	16	13	16	18	10	8	0	10
7 ,,	12	15	24	24	26	21	22	25	27	21	20	13	21
8 ,,	30	27	33	36	30	26	27	32	32	31	32	28	30
9 ,,	40	34	38	42	30	27	29	36	34	35	36	25	35
10 ,,	38	34	35	38	26	26	29	34	30	32	30	30	32
11 ,,	24	22	25	25	18	22	25	27	20	21	15	24	32
Noon	5	5	9	8	9	13	18	15	7	5	3	5	7
1 P.M.	8	12	1	9	0	2	7	1	7	12	8	20	4
2 ,,	21	25	28	21	10	12	5	14	19	23	16	26	18
3 ,,	25	31	39	30	20	24	18	26	28	30	29	25	27
4 ,,	24	31	41	35	30	32	28	31	33	31	27	20	30
5 ,,	21	26	37	35	35	34	31	34	33	27	22	12	29
6 ,,	14	18	28	29	32	30	28	29	28	19	14	4	23
7 ,,	5	10	19	18	22	21	19	21	19	9	4	4	13
8 ,,	2	3	10	6	8	11	8	13	10	0	4	8	5
9 ,,	4	2	3	2	2	2	1	6	2	5	8	8	2
10 ,,	1	4	4	4	6	3	5	1	3	5	6	4	4
11 ,,	4	4	8	2	4	3	3	0	4	2	2	0	2
Midt.	7	3	9	2	2	0	3	1	2	1	2	2	1

FORT RAE.—One Year.
Lat. N. 62° 39′, Long. W. 115° 44′; Height, 530 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	3	6	6	4	9	1	1	8	6	5	4	2
2	3	5	6	3	9	0	4	11	5	3	7	2
4	3	3	4	1	8	1	2	10	5	2	10	1
3	3	1	2	3	8	1	1	12	7	3	6	0
1	4	2	3	7	8	3	2	11	6	1	5	1
2	2	4	6	9	10	7	4	4	3	0	3	3
4	0	6	10	11	10	8	7	2	1	0	3	4
0	0	8	11	12	11	10	5	1	1	5	3	5
3	2	11	12	14	9	11	4	3	6	6	4	7
5	3	13	13	13	6	9	4	4	6	9	3	7
8	6	13	11	12	3	8	5	5	7	8	1	7
4	2	12	9	10	2	6	6	4	6	8	5	5
2	2	11	8	6	1	4	3	6	3	6	7	3
2	5	8	5	2	3	3	1	8	2	4	6	2
4	6	1	1	2	6	1	2	10	3	4	5	0
3	5	1	2	6	11	6	4	10	3	2	4	2
3	5	4	7	8	13	10	6	13	2	2	3	3
1	0	8	10	10	14	11	6	13	2	2	2	4
3	2	6	10	13	14	12	7	4	0	7	4	6
4	2	6	10	14	13	11	6	3	1	8	5	6
4	1	9	8	12	8	10	2	0	2	9	3	6
6	1	10	7	11	4	7	1	3	3	9	2	5
7	1	11	6	9	1	5	1	3	4	7	2	4
8	3	11	3	5	1	3	2	8	6	2	3	4

SITKA.—Twenty-Three Years.
Lat. N. 57° 3′, Long. W. 135° 18′; Height, 28 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	2	5	2	3	1	1	0	1	2	4	2	2
2 ,,	4	3	4	3	1	1	2	2	1	1	1	2	1
3 ,,	3	0	1	6	2	2	4	3	3	3	2	1	2
4 ,,	·0	2	2	8	4	5	4	6	5	4	3	5	4
5 ,,	1	2	4	9	6	6	5	7	6	4	4	6	5
6 ,,	2	3	6	7	6	6	5	6	6	5	4	7	5
7 ,,	3	4	8	6	5	6	5	6	5	4	4	7	5
8 ,,	2	3	8	5	4	6	4	4	3	2	1	6	4
9 ,,	0	0	6	3	3	6	3	2	1	1	1	0	2
10 ,,	6	5	2	0	2	4	2	1	2	3	4	6	1
11 ,,	7	8	2	4	1	1	0	2	4	6	5	8	4
Noon	7	9	3	6	4	3	2	4	7	7	4	8	5
1 P.M.	4	6	3	7	4	5	4	6	8	6	2	5	5
2 ,,	0	3	2	8	5	6	6	7	7	4	1	2	4
3 ,,	2	0	0	6	4	6	6	7	5	2	4	1	2
4 ,,	3	2	2	3	3	6	5	4	2	1	5	0	1
5 ,,	4	4	3	1	2	4	3	2	1	4	5	0	1
6 ,,	6	5	4	1	1	3	1	0	3	4	4	1	2
7 ,,	6	5	1	1	2	1	0	1	2	3	2	1	2
8 ,,	5	4	1	1	2	1	0	0	1	2	0	1	1
9 ,,	2	2	3	3	1	3	1	1	0	0	2	1	1
10 ,,	1	0	5	4	2	3	2	1	1	2	4	0	2
11 ,,	1	0	6	4	2	4	2	0	1	2	5	1	2
Midt.	2	0	6	5	4	2	2	0	0	2	5	2	3

ASTORIA.— *Years.
Lat. N. 46° 11′, Long. W. 123° 50′; Height, 53 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
4	12	8	3	3	2	...	3	2	1	5	7	0
8	12	4	4	7	4	1	4	3	3	0	3	3
11	12	2	10	10	6	2	5	4	6	8	1	6
13	10	1	13	11	7	3	6	5	7	5	3	7
7	8	1	8	8	3	2	1	2	4	2	0	3
0	3	2	4	2	5	9	5	7	0	4	7	3
9	7	6	18	7	10	14	11	13	11	8	9	10
22	16	9	25	10	13	18	14	21	17	16	13	16
31	19	15	29	11	14	17	16	25	20	18	25	20
36	21	14	31	14	15	17	17	27	22	20	29	22
26	23	7	16	10	12	15	15	23	20	17	15	17
12	16	2	12	6	8	11	12	14	9	5	1	9
7	6	14	7	1	3	6	8	8	3	4	17	1
19	1	23	6	5	5	3	0	3	6	12	23	9
21	6	23	16	11	12	12	6	12	9	14	27	14
18	8	23	24	18	19	18	11	20	13	16	23	18
16	11	20	27	22	23	22	17	24	15	16	20	19
15	6	15	28	8	16	22	20	25	15	15	12	16
11	1	6	18	9	5	18	16	18	11	10	9	9
1	1	5	1	13	2	9	6	11	7	5	2	2
1	2	8	4	16	7	1	3	7	4	1	2	2
2	6	13	3	12	6	0	2	5	2	4	9	3
4	9	13	6	4	2	1	1	3	1	7	13	3
1	11	12	7	0	0	2	2	1	0	9	15	2

* From Williamson's "On the Use of the Barometer."

SAN FRANCISCO.— *YEARS.
LAT. N. 37° 48′, LONG. W. 122° 23′; HEIGHT, 22 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	1	3	3	10	2	12	8	6	4	4	3	2	2
2 ,,	0	2	7	14	6	15	9	8	4	4	1	4	4
3 ,,	1	1	12	16	10	16	10	9	5	4	0	5	5
4 ,,	2	0	14	18	12	17	11	10	5	4	1	6	6
5 ,,	3	0	9	12	6	9	1	3	1	8	1	1	2
6 ,,	0	7	2	0	2	1	13	8	10	14	3	4	5
7 ,,	11	12	12	11	6	13	22	20	25	23	13	8	16
8 ,,	21	22	24	17	14	22	28	26	32	35	28	20	25
9 ,,	36	29	35	26	16	25	32	31	41	40	37	35	33
10 ,,	44	31	36	31	17	30	34	33	40	39	38	41	35
11 ,,	32	35	32	26	17	30	32	29	33	32	29	36	30
Noon	12	20	21	18	13	25	27	22	20	16	13	8	19
1 P.M.	14	2	4	8	10	18	16	12	7	6	6	16	4
2 ,,	26	18	10	4	3	6	4	3	9	20	13	30	9
3 ,,	33	25	18	14	5	5	10	17	23	29	20	34	19
4 ,,	36	32	25	19	10	14	25	27	32	36	23	34	25
5 ,,	35	34	30	22	21	22	34	32	37	37	27	34	29
6 ,,	29	30	31	27	21	25	32	33	38	34	18	29	28
7 ,,	22	23	23	22	17	23	30	30	30	27	6	22	22
8 ,,	12	15	15	8	7	18	23	17	15	18	1	14	13
9 ,,	4	11	7	1	2	7	14	7	9	8	7	9	5
10 ,,	1	7	1	0	4	2	10	3	6	4	12	5	0
11 ,,	6	2	4	1	4	4	7	2	4	0	12	1	2
Midt.	2	4	2	3	3	8	7	3	3	3	8	0	1

SACRAMENTO.— *YEARS.
LAT. N. 38° 34′, LONG. W. 121° 19′; HEIGHT, 81 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	0	5	4	1	1	8	2	1	10	5	6	3
2 ,,	5	1	12	8	8	4	9	6	2	9	0	8	5
3 ,,	6	2	15	14	12	6	7	7	4	7	4	9	6
4 ,,	6	3	17	17	14	6	5	9	5	4	6	9	6
5 ,,	1	1	11	11	10	1	2	12	8	8	2	3	1
6 ,,	7	8	0	0	1	9	7	14	19	19	5	3	8
7 ,,	19	18	20	28	23	24	24	29	25	31	13	16	22
8 ,,	23	28	33	32	30	27	30	33	32	38	24	31	29
9 ,,	33	33	41	39	32	28	35	38	39	45	33	39	35
10 ,,	41	36	46	42	32	29	36	37	39	47	38	41	39
11 ,,	34	31	44	36	32	29	33	33	36	43	29	37	34
Noon	12	17	33	26	24	26	28	26	23	26	7	18	22
1 P.M.	7	6	12	15	14	18	21	13	7	8	10	1	7
2 ,,	24	26	2	2	7	7	9	1	8	11	19	16	7
3 ,,	29	30	15	10	4	6	5	16	20	21	26	23	18
4 ,,	29	32	27	23	14	16	18	28	28	29	29	27	25
5 ,,	24	32	34	30	28	29	27	37	32	32	29	25	31
6 ,,	19	26	36	34	34	35	32	41	34	31	23	19	31
7 ,,	15	19	31	31	30	32	32	43	33	30	17	15	28
8 ,,	9	9	21	21	22	30	29	37	27	23	10	10	21
9 ,,	1	2	11	13	12	23	22	28	23	16	4	7	14
10 ,,	3	6	1	1	3	9	14	21	15	12	5	3	6
11 ,,	3	7	5	3	2	1	9	11	10	10	10	1	1
Midt.	1	4	3	2	3	1	7	1	8	10	10	3	1

FORT CHURCHILL.— *YEARS.
LAT. N. 39° 18′, LONG. W. 119° 15′; HEIGHT, 4319 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	5	1	22	15	19	14	14	9	4	5	1	7
2 ,,	11	4	3	24	15	21	16	18	13	1	8	6	6
3 ,,	13	9	4	26	15	22	19	19	15	2	9	10	6
4 ,,	14	11	4	28	16	25	23	22	16	6	10	12	7
5 ,,	11	6	11	33	19	31	28	26	21	12	7	1	13
6 ,,	4	3	20	36	24	37	34	33	31	20	0	8	20
7 ,,	8	18	34	38	33	39	39	41	41	26	11	22	29
8 ,,	16	20	35	31	31	32	36	39	40	34	19	33	31
9 ,,	24	24	41	31	29	26	32	32	33	42	28	42	32
10 ,,	41	25	36	29	15	21	25	24	34	42	33	43	31
11 ,,	32	22	31	20	4	11	16	8	23	34	33	23	21
Noon	13	7	18	10	9	4	1	6	10	17	16	0	6
1 P.M.	3	13	5	8	20	13	15	16	7	6	9	13	11
2 ,,	19	26	22	30	29	29	31	27	24	23	26	19	25
3 ,,	26	29	33	50	38	40	38	36	35	35	35	25	35
4 ,,	22	33	39	69	42	48	47	44	45	38	23	27	40
5 ,,	18	28	40	73	45	51	52	46	47	40	17	24	40
6 ,,	8	20	33	69	42	47	49	43	46	31	7	22	35
7 ,,	5	12	21	50	23	40	39	32	38	15	5	18	24
8 ,,	3	1	16	25	8	25	22	22	27	8	4	13	14
9 ,,	1	12	10	8	5	10	4	12	20	6	3	7	5
10 ,,	5	15	2	8	8	4	4	4	11	4	2	1	2
11 ,,	5	16	2	18	11	14	8	4	2	6	1	6	6
Midt.	1	13	1	21	14	17	12	9	5	6	3	7	8

FORT YUMA—. *YEARS.
LAT. N. 32° 35′, LONG. W. 114° 36′; HEIGHT, 141 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	18	14	...	...	...	...	...	...	...	...	...
2 ,,	...	...	8	6	...	...	...	...	...	...	...	...	...
3 ,,	...	...	2	4	...	...	...	...	...	...	...	...	...
4 ,,	...	...	2	5	...	...	...	...	...	...	...	...	...
5 ,,	...	...	6	4	...	...	...	...	...	...	...	...	...
6 ,,	...	...	20	18	...	...	...	...	...	...	...	...	...
7 ,,	...	...	30	34	...	...	...	...	...	...	...	...	...
8 ,,	...	...	46	46	...	...	...	...	...	...	...	...	...
9 ,,	...	...	58	52	...	...	...	...	...	...	...	...	...
10 ,,	...	...	50	59	...	...	...	...	...	...	...	...	...
11 ,,	...	...	40	47	...	...	...	...	...	...	...	...	...
Noon	...	...	26	28	...	...	...	...	...	...	...	...	...
1 P.M.	...	...	0	11	...	...	...	...	...	...	...	...	...
2 ,,	...	...	30	15	...	...	...	...	...	...	...	...	...
3 ,,	...	...	46	35	...	...	...	...	...	...	...	...	...
4 ,,	...	...	57	50	...	...	...	...	...	...	...	...	...
5 ,,	...	...	58	62	...	...	...	...	...	...	...	...	...
6 ,,	...	...	52	54	...	...	...	...	...	...	...	...	...
7 ,,	...	...	38	43	...	...	...	...	...	...	...	...	...
8 ,,	...	...	26	32	...	...	...	...	...	...	...	...	...
9 ,,	...	...	8	14	...	...	...	...	...	...	...	...	...
10 ,,	...	...	4	0	...	...	...	...	...	...	...	...	...
11 ,,	...	...	10	12	...	...	...	...	...	...	...	...	...
Midt.	...	...	16	14	...	...	...	...	...	...	...	...	...

* From Williamson's "On the Use of the Barometer."

MEXICO.—ONE YEAR.
LAT. N. 19° 26′, LONG. W. 99° 0′; HEIGHT, 7490 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	10	13	12	14	17	7	5	10	8	9	8	11	10
2 ,,	5	4	1	6	6	1	1	1	2	1	2	3	2
3 ,,	1	2	4	1	2	4	5	4	2	3	0	1	2
4 ,,	3	3	2	1	6	2	3	1	3	2	1	1	0
5 ,,	9	4	4	9	9	4	7	6	9	5	6	7	7
6 ,,	18	17	18	21	21	13	19	20	19	19	21	17	19
7 ,,	35	34	30	35	30	26	31	29	29	28	32	30	31
8 ,,	51	44	43	45	35	32	37	32	40	41	44	47	41
9 ,,	60	50	52	48	36	35	39	39	44	47	54	54	47
10 ,,	57	50	49	42	30	28	33	36	38	43	43	48	41
11 ,,	35	37	30	24	15	18	20	25	25	27	23	31	26
Noon	7	9	5	2	2	3	7	9	3	3	4	1	4
1 P.M.	25	21	26	27	22	13	34	10	17	21	29	28	23
2 ,,	47	47	44	44	41	31	29	30	46	47	56	50	43
3 ,,	59	60	64	57	53	47	47	49	63	61	67	62	57
4 ,,	63	66	70	67	63	54	57	54	65	63	67	60	62
5 ,,	58	63	63	63	61	49	53	52	58	54	55	50	57
6 ,,	50	51	50	52	41	35	40	38	44	38	42	40	43
7 ,,	31	33	33	32	22	19	24	23	13	18	18	19	24
8 ,,	9	7	3	4	2	5	4	6	2	7	4	3	2
9 ,,	8	11	19	20	19	11	10	8	23	21	23	17	16
10 ,,	16	21	27	32	29	23	22	22	27	24	26	21	24
11 ,,	13	22	27	31	32	27	26	22	24	19	25	18	24
Midt.	11	18	20	27	23	17	22	15	17	16	20	16	19

RIO JANEIRO.—TEN YEARS.
LAT. S. 22° 57′, LONG. W. 43° 7′; HEIGHT, 224 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
9	9	12	7	11	12	14	6	2	5	4	6	8
1	4	8	5	9	8	11	3	2	4	2	0	3
5	3	2	5	1	2	4	3	12	12	8	8	4
11	10	13	15	15	14	16	15	20	20	16	12	15
17	17	20	21	21	23	21	23	24	21	19	15	20
18	17	20	19	19	21	23	22	22	21	16	15	20
13	16	16	13	13	15	16	17	15	13	11	11	14
7	9	9	7	3	4	6	5	0	4	2	6	5
2	2	0	8	5	5	4	5	13	7	5	1	5
9	9	9	12	11	10	8	15	18	14	11	8	11
17	13	12	16	15	12	13	19	22	19	18	18	16
20	21	15	17	13	12	10	19	21	23	18	20	17
19	19	16	18	10	14	11	21	18	21	19	20	16
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...

CORDOVA.—FIVE YEARS.
LAT. S. 31° 25′, LONG. W. 64° 11′; HEIGHT, 1460 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	18	24	23	18	26	19	27	33	31	33	28	26	26
2 ,,	19	24	24	20	25	18	26	30	30	33	25	25	25
3 ,,	17	24	24	20	23	17	24	27	26	31	23	22	23
4 ,,	18	23	23	19	22	15	21	24	23	30	23	22	22
5 ,,	20	24	24	19	21	13	19	21	23	30	25	26	22
6 ,,	27	27	24	22	21	13	16	21	26	33	30	32	24
7 ,,	33	32	25	25	22	13	19	23	32	37	36	40	28
8 ,,	39	36	27	29	25	15	20	28	40	39	39	45	31
9 ,,	38	37	30	29	26	19	23	30	40	38	38	44	33
10 ,,	34	32	26	27	26	22	26	31	36	32	30	38	30
11 ,,	27	24	17	17	16	11	15	19	22	20	20	28	20
Noon	19	14	6	2	3	6	4	2	4	6	9	18	5
1 P.M.	5	0	7	15	23	23	26	26	20	17	14	3	14
2 ,,	9	16	24	33	42	38	44	49	45	38	29	15	32
3 ,,	28	39	41	43	49	43	49	61	60	60	50	42	47
4 ,,	47	54	52	47	50	42	47	61	63	68	62	60	54
5 ,,	54	56	51	48	43	34	42	52	61	66	63	65	53
6 ,,	57	55	47	42	37	27	33	45	54	57	57	65	48
7 ,,	55	50	38	33	27	17	22	33	43	48	51	61	40
8 ,,	47	43	27	22	16	6	11	18	29	35	38	50	28
9 ,,	32	27	14	10	6	3	0	4	12	17	17	30	14
10 ,,	12	7	1	2	5	14	11	10	5	0	3	10	2
11 ,,	9	11	13	17	17	23	19	25	22	18	20	9	17
Midt.	19	22	20	23	20	26	22	30	28	26	28	18	23

SANTIAGO DE CHILE.—THREE YEARS.
LAT. S. 33° 22′, LONG. E. 70° 38′; HEIGHT, 1790 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
6	2	22	16	7	9	11	18	11	7	8	10	11
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
8	13	2	4	3	2	5	5	11	3	9	13	4
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
17	23	26	25	25	19	14	18	19	10	14	16	19
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
12	11	6	1	5	2	4	8	3	0	1	5	5
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
17	18	22	22	17	19	19	18	24	20	24	20	20
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
23	25	20	11	8	4	0	5	8	6	14	23	12
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
7	11	15	3	6	3	7	13	11	13	14	9	8
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
1	9	4	1	1	4	6	9	1	1	1	0	1

BUENOS AYRES.— YEARS.
LAT. S. 34° 39′, LONG. W. 58° 23′; HEIGHT, 12 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Period.
1 A.M.	...	...	2	...	...	...	1	...	0	...	...	2	1
2 "	...	...	7	...	...	...	2	...	4	...	...	7	5
3 "	...	...	11	...	...	...	3	...	6	...	...	9	7
4 "	...	...	11	...	...	...	1	...	6	...	...	7	6
5 "	...	...	6	...	...	...	4	...	1	...	...	1	1
6 "	...	...	4	...	...	...	12	...	8	...	...	15	10
7 "	...	...	18	...	...	...	20	...	20	...	...	32	22
8 "	...	...	30	...	...	...	23	...	27	...	...	45	33
9 "	...	...	37	...	...	...	31	...	37	...	...	51	39
10 "	...	...	35	...	...	...	23	...	36	...	...	48	37
11 "	...	...	25	...	...	...	20	...	28	...	...	36	27
Noon	...	...	11	...	...	...	7	...	14	...	...	18	13
1 P.M.	...	...	5	...	...	...	6	...	3	...	...	1	4
2 "	...	...	17	...	...	...	17	...	19	...	...	17	17
3 "	...	...	23	...	...	...	24	...	30	...	...	27	26
4 "	...	...	25	...	...	...	25	...	35	...	...	31	29
5 "	...	...	22	...	...	...	22	...	33	...	...	29	27
6 "	...	...	17	...	...	...	16	...	26	...	...	25	21
7 "	...	...	11	...	...	...	9	...	17	...	...	19	14
8 "	...	...	6	...	...	...	3	...	7	...	...	12	7
9 "	...	...	2	...	...	...	2	...	0	...	...	6	2
10 "	...	...	2	...	...	...	4	...	4	...	...	1	2
11 "	...	...	3	...	...	...	5	...	6	...	...	2	4
Midt.	...	...	3	...	...	...	3	...	4	...	...	2	3

SOUTH GEORGIA.—ONE YEAR.
LAT. S. 54° 31′, LONG. W. 36° 5′; HEIGHT, 30 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	3	11	8	8	3	7	15	5	8	26	1	4
5	4	4	7	5	8	2	14	7	5	20	5	1
8	11	6	11	5	8	1	8	13	3	19	6	2
9	14	9	11	2	15	5	8	13	1	19	6	4
3	14	6	10	3	18	10	9	6	1	21	3	2
2	10	5	4	3	17	17	10	2	6	19	2	2
5	8	1	2	1	13	16	8	10	8	16	3	4
10	2	1	7	2	7	21	3	14	8	14	9	7
12	0	2	19	6	8	35	12	17	8	7	9	11
8	0	1	20	5	15	36	12	14	6	3	6	10
4	1	6	17	1	14	31	4	13	1	10	1	6
2	3	9	12	8	6	22	3	9	7	20	1	0
4	4	12	5	16	0	11	18	5	10	27	1	5
4	5	10	2	17	1	4	27	3	14	30	2	9
6	2	11	6	18	1	16	30	7	15	35	4	12
8	1	10	8	13	5	23	29	13	14	35	6	12
9	2	8	6	8	7	27	24	14	13	30	6	10
5	6	3	4	5	10	28	14	5	12	19	2	6
4	8	6	0	12	9	22	4	3	7	9	1	1
8	14	15	0	13	8	20	1	1	7	8	0	4
7	9	19	2	12	5	16	7	4	8	10	3	6
5	4	17	2	11	6	16	11	6	6	15	3	5
5	2	14	5	8	2	12	12	0	9	23	2	5
4	1	14	5	9	0	9	13	4	11	23	3	5

PORT LOUIS.—SEVEN MONTHS.
LAT. S. 53° 38′, LONG. W. 70° 54′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Period.
1 A.M.	...	...	...	12	14	7	27	17	10	...	...	5	12
2 "	...	...	...	13	15	1	20	13	7	...	...	2	10
3 "	...	...	...	9	9	2	21	6	8	...	...	0	7
4 "	...	...	...	6	8	3	9	1	7	...	...	1	4
5 "	...	...	...	9	6	8	6	3	4	...	...	7	1
6 "	...	...	...	15	2	9	9	7	6	...	...	8	1
7 "	...	...	...	15	4	8	10	7	7	...	...	10	2
8 "	...	...	...	17	7	9	11	5	3	...	...	8	1
9 "	...	...	...	15	12	3	9	6	6	...	...	0	1
10 "	...	...	...	12	8	1	10	6	0	...	...	3	0
11 "	...	...	...	7	9	7	10	5	5	...	...	4	0
Noon	...	...	...	3	0	4	16	11	12	...	...	6	5
1 P.M.	...	...	...	11	12	40	24	19	13	...	...	10	18
2 "	...	...	...	18	18	47	29	22	14	...	...	11	23
3 "	...	...	...	19	18	12	22	20	17	...	...	10	17
4 "	...	...	...	20	14	4	16	12	14	...	...	8	13
5 "	...	...	...	18	12	3	5	4	12	...	...	6	8
6 "	...	...	...	15	9	7	4	3	8	...	...	3	3
7 "	...	...	...	12	8	13	8	8	2	...	...	3	1
8 "	...	...	...	9	5	17	9	14	4	...	...	0	4
9 "	...	...	...	8	4	20	16	19	5	...	...	1	7
10 "	...	...	...	3	4	22	20	21	7	...	...	5	8
11 "	...	...	...	3	1	21	23	18	9	...	...	5	11
Midt.	...	...	...	5	4	21	25	21	9	...	...	4	12

KERGUELEN.—SIX MONTHS.
LAT. S. 50° 0′, LONG. E. 70° 0′; near Sea Level.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Period.
11	...	...	...	18	0	32	...	...	...	12	7	3
5	...	...	...	28	6	29	...	...	...	11	9	4
4	...	...	...	32	3	27	...	...	...	4	7	7
4	...	...	...	33	1	18	...	...	...	5	6	9
2	...	...	...	30	6	14	...	...	...	0	10	5
6	...	...	...	26	12	12	...	...	...	4	16	2
10	...	...	...	18	15	8	...	...	...	4	10	1
12	...	...	...	14	17	5	...	...	...	1	6	1
13	...	...	...	0	19	5	...	...	...	6	7	4
19	...	...	...	7	22	15	...	...	...	11	8	7
15	...	...	...	16	15	25	...	...	...	4	3	7
13	...	...	...	21	2	25	...	...	...	4	20	2
10	...	...	...	26	10	21	...	...	...	8	12	1
1	...	...	...	21	18	24	...	...	...	11	7	2
1	...	...	...	19	13	33	...	...	...	14	5	3
1	...	...	...	24	12	37	...	...	...	18	3	4
4	...	...	...	19	14	32	...	...	...	15	8	3
7	...	...	...	19	15	19	...	...	...	14	12	1
3	...	...	...	23	16	11	...	...	...	2	10	0
10	...	...	...	18	14	3	...	...	...	8	8	2
12	...	...	...	9	3	16	...	...	...	6	4	1
15	...	...	...	1	4	22	...	...	...	5	1	1
15	...	...	...	7	0	29	...	...	...	8	3	2
11	...	...	...	14	1	36	...	...	...	11	5	4

SSEGASTAR, Mouth of the Lena.—Two Years.
Lat. N. 73° 23′, Long. E. 124° 5′; Height, 16 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	1	1	2	1	6	1	4	2	2	3	2	1
2 "	3	1	2	3	0	3	2	2	3	2	1	3	0
3 "	3	2	3	6	3	2	3	0	5	4	0	2	2
4 "	2	2	2	6	3	2	2	2	2	3	1	0	1
5 "	5	2	1	5	2	2	0	5	2	2	2	1	1
6 "	4	1	1	3	2	1	1	6	0	1	0	2	1
7 "	3	2	1	3	4	0	2	9	1	0	0	6	2
8 "	2	3	0	3	5	1	2	9	2	1	1	4	1
9 "	1	0	0	4	6	4	2	8	2	2	4	5	3
10 "	1	2	0	3	6	6	2	10	1	4	6	9	4
11 "	5	4	3	3	6	6	2	11	0	4	7	10	5
Noon	7	4	4	2	6	7	2	10	2	6	7	9	6
1 P.M.	9	6	7	2	6	7	3	13	3	6	6	9	6
2 "	6	4	6	1	3	8	3	11	5	4	4	7	5
3 "	6	3	5	2	2	8	1	7	5	3	3	1	4
4 "	3	2	3	0	1	6	2	2	4	0	1	2	2
5 "	0	2	3	4	3	3	2	4	0	4	1	6	2
6 "	2	7	7	8	8	0	2	10	5	7	2	7	5
7 "	3	7	8	10	9	5	5	17	8	8	3	8	8
8 "	3	6	7	10	9	5	6	16	6	8	2	10	7
9 "	2	4	6	7	9	5	4	12	4	6	2	7	6
10 "	1	2	6	5	8	7	4	12	3	3	1	6	5
11 "	0	1	3	1	4	7	4	9	1	1	1	3	3
Midt.	1	0	3	1	3	5	1	7	0	0	1	3	2

KLEINE KARMAKUL (NOVA ZEMBLA).—One Year.
Lat. N. 72° 23′, Long. E. 52° 43′; Height, 23 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
12	15	0	1	0	4	0	8	0	5	1	5	2
9	11	1	1	4	6	0	8	6	4	3	6	1
10	13	0	4	6	8	3	6	11	1	2	3	1
5	11	1	4	8	7	2	5	10	5	2	0	7
1	0	6	5	10	10	4	2	9	6	1	2	4
3	3	7	6	9	12	2	2	9	10	1	2	5
8	6	8	8	8	11	2	4	8	10	4	3	5
11	10	7	8	3	11	5	6	8	11	4	6	6
13	17	7	6	3	9	4	10	8	10	3	6	6
14	15	6	4	2	8	4	14	8	9	2	4	5
23	13	5	2	0	5	3	11	5	5	1	4	2
24	10	3	2	6	4	2	10	3	3	6	1	1
24	5	1	4	7	6	1	3	2	0	8	6	4
21	1	3	4	8	8	1	3	6	4	8	7	5
15	2	5	8	12	11	5	0	7	5	5	7	6
10	3	7	8	11	12	3	0	10	7	2	4	6
1	2	6	5	11	13	2	1	8	6	1	3	4
9	2	6	5	9	11	1	3	8	6	5	3	3
13	3	5	2	4	7	1	6	10	6	7	2	2
19	4	4	2	2	6	3	5	10	6	5	1	2
21	4	4	5	1	2	2	6	10	8	4	1	1
21	8	5	5	3	3	3	7	5	6	4	1	1
23	8	6	2	4	2	0	6	5	9	2	1	1
23	7	1	1	2	2	2	5	2	8	2	1	0

SODANKYLÄ.—Two Years,
Lat. N. 67° 27′, Long. E. 26° 36′; Height, 617 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	1	9	0	4	5	1	4	7	9	2	4	4
2 "	0	1	10	0	7	8	4	4	6	8	2	2	4
3 "	2	2	12	0	7	10	5	5	2	4	0	1	3
4 "	3	6	12	2	8	12	5	6	2	1	1	1	3
5 "	5	10	13	2	7	12	6	6	4	2	3	4	1
6 "	7	10	11	5	8	12	10	5	4	4	6	9	1
7 "	10	12	10	6	8	12	8	8	1	8	9	11	0
8 "	10	11	5	6	7	12	7	7	1	9	9	9	0
9 "	5	6	1	6	7	11	8	6	5	3	6	6	1
10 "	0	1	1	4	6	8	9	5	5	1	2	1	2
11 "	3	2	0	4	6	4	5	4	5	1	4	4	3
Noon	1	1	4	1	3	3	4	2	8	2	4	3	1
1 P.M.	2	3	6	1	1	1	0	0	5	4	1	0	1
2 "	1	4	9	5	3	1	3	4	6	5	1	1	3
3 "	1	6	11	6	8	12	7	8	6	6	2	2	5
4 "	2	4	12	8	10	15	10	12	3	4	1	3	6
5 "	4	6	12	8	12	18	10	11	0	5	1	3	5
6 "	5	6	9	7	14	18	10	11	1	4	1	1	5
7 "	5	6	8	4	13	19	13	12	5	0	2	0	4
8 "	6	7	8	0	9	16	10	8	9	5	3	2	2
9 "	3	3	7	0	7	9	6	6	12	5	4	2	1
10 "	3	4	4	1	3	4	2	2	13	7	4	5	2
11 "	4	4	2	1	3	1	0	1	13	7	4	6	3
Midt.	2	5	6	0	1	3	1	4	13	8	4	4	4

BOSSEKOP.—One Year.
Lat. N. 69° 57′, Long. E. 23° 15′; Height, 98 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
2	1	8	0	3	12	8	10	4	4	1	2	5
1	1	9	1	2	13	9	8	1	2	2	0	4
1	1	8	0	1	13	10	4	5	3	2	2	2
6	2	8	1	0	11	8	0	7	4	4	5	0
8	5	2	1	3	9	8	2	8	8	4	6	2
7	6	2	1	3	6	7	4	12	9	5	6	3
9	7	2	1	3	3	6	6	12	10	7	8	5
5	11	5	4	2	2	5	4	12	7	6	5	4
2	10	6	4	1	2	4	2	13	8	1	1	2
2	10	4	3	0	2	2	2	8	5	6	4	1
5	4	4	3	4	0	1	0	8	3	10	10	1
5	3	3	2	3	1	4	1	5	2	6	8	1
3	2	2	0	4	2	8	1	3	2	4	4	0
2	2	3	0	4	6	10	3	2	4	3	1	1
1	7	3	2	2	10	11	3	1	2	1	2	2
2	9	6	2	2	14	12	4	3	2	0	1	2
3	7	7	0	4	15	13	3	6	3	1	1	2
3	6	6	1	7	13	11	1	9	5	0	2	2
0	5	4	2	8	11	10	0	13	9	1	4	1
1	3	2	2	4	10	8	0	16	10	1	3	0
3	5	3	2	3	6	2	2	14	12	0	1	2
1	4	7	2	2	0	4	2	13	10	1	4	4
4	4	8	0	4	6	7	4	12	10	0	5	5
5	2	9	1	5	9	10	6	8	8	1	4	5

JAN MAYEN.—One Year.
Lat. N. 70° 59′, Long. W. 8° 28′; Height, 35 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	12	1	8	7	2	0	1	4	3	2	5	2	0
2 ,,	10	4	4	6	2	2	1	3	4	7	5	2	1
3 ,,	4	4	2	4	2	5	5	4	8	11	7	5	3
4 ,,	2	4	0	4	4	8	6	8	13	10	8	7	6
5 ,,	9	6	1	2	3	7	8	7	12	10	8	9	5
6 ,,	10	3	4	2	2	7	6	2	9	7	6	6	4
7 ,,	5	4	8	1	1	2	3	1	6	2	4	5	1
8 ,,	2	4	9	4	0	1	0	1	4	2	0	2	1
9 ,,	0	4	13	2	0	0	2	4	2	5	6	2	3
10 ,,	1	3	10	1	2	2	2	4	3	8	9	7	4
11 ,,	0	3	11	1	3	2	4	9	5	8	9	6	5
Noon	2	4	10	1	2	6	6	11	8	9	7	4	5
1 P.M.	7	3	10	2	0	7	6	7	7	9	6	1	4
2 ,,	7	2	9	0	0	5	6	7	6	5	4	3	4
3 ,,	11	1	0	3	1	2	4	3	5	1	3	6	0
4 ,,	11	3	4	5	2	1	2	1	2	2	1	2	2
5 ,,	10	8	6	5	3	2	1	1	2	3	3	0	3
6 ,,	4	11	7	6	2	2	1	2	4	6	0	2	2
7 ,,	3	9	8	3	2	0	1	2	8	5	3	2	0
8 ,,	9	2	12	0	4	3	1	2	7	2	0	3	0
9 ,,	10	2	11	1	3	3	1	1	5	1	0	4	1
10 ,,	10	2	12	2	1	4	0	1	2	1	1	2	1
11 ,,	11	3	13	1	4	2	0	0	3	5	3	3	0
Midt.	9	2	12	3	4	4	0	0	1	9	3	1	0

SABINE ISLAND.—One Year.
Lat. N. 74° 32′, Long. W. 18° 49′; Height, 0 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
...	...	...	...	...	...	...	...	...	...	...	...	...
11	9	13	2	5	8	3	2	0	5	12	10	1
...	...	...	...	...	...	...	...	...	...	...	...	...
2	5	8	2	11	6	4	1	3	3	12	9	3
...	...	...	...	...	...	...	...	...	...	...	...	...
0	12	0	7	10	3	5	1	2	1	6	6	1
...	...	...	...	...	...	...	...	...	...	...	...	...
6	12	11	11	5	1	7	5	0	4	2	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...
14	21	11	9	4	3	8	2	3	17	1	2	1
...	...	...	...	...	...	...	...	...	...	...	...	...
14	19	8	9	14	9	6	4	5	11	1	4	3
...	...	...	...	...	...	...	...	...	...	...	...	...
15	15	8	2	12	3	1	2	4	8	4	10	0
...	...	...	...	...	...	...	...	...	...	...	...	...
11	2	2	7	11	0	7	9	5	2	1	8	3
...	...	...	...	...	...	...	...	...	...	...	...	...
2	11	2	7	3	0	8	2	4	1	10	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...
11	19	0	3	2	1	11	3	2	6	12	3	1
...	...	...	...	...	...	...	...	...	...	...	...	...
16	25	5	3	2	2	6	7	3	9	11	2	3
...	...	...	...	...	...	...	...	...	...	...	...	...
18	22	6	10	6	3	1	9	2	15	4	3	1

GODTHAAB.—One Year.
Lat. N. 64° 11′, Long. W. 51° 46′; Height, 37 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	6	6	6	2	4	14	5	6	7	18	9	7
2 ,,	10	7	6	9	1	4	14	8	6	4	22	10	8
3 ,,	3	3	2	9	0	5	10	5	8	2	16	7	6
4 ,,	0	1	4	5	2	3	4	2	9	3	12	6	3
5 ,,	1	2	11	0	2	0	0	1	7	4	9	4	1
6 ,,	1	2	12	3	0	0	5	2	7	5	6	3	1
7 ,,	3	1	12	8	1	1	6	5	8	4	5	2	1
8 ,,	1	5	16	11	3	0	8	4	9	10	3	1	3
9 ,,	0	6	12	9	2	1	10	3	9	8	1	0	3
10 ,,	0	6	9	9	1	5	11	5	7	7	1	1	3
11 ,,	1	5	12	8	1	4	10	0	6	2	4	6	2
Noon	6	2	2	4	3	9	9	4	7	6	2	9	2
1 P.M.	9	2	2	2	4	6	9	5	6	5	4	10	3
2 ,,	6	4	4	2	3	6	8	7	4	6	9	6	2
3 ,,	3	2	6	1	0	2	5	4	0	4	12	2	0
4 ,,	5	4	9	3	4	0	1	1	8	1	17	9	2
5 ,,	9	6	5	7	6	2	2	2	10	2	16	15	4
6 ,,	10	7	5	10	1	3	3	3	13	2	16	15	4
7 ,,	8	2	10	4	6	8	3	4	14	1	13	14	5
8 ,,	5	4	1	4	8	14	4	6	20	2	10	12	6
9 ,,	5	2	3	1	8	16	2	5	20	0	4	8	5
10 ,,	5	3	6	1	8	18	3	6	12	2	1	4	3
11 ,,	3	6	9	3	3	9	6	1	6	6	6	3	1
Midt.	2	11	11	4	2	0	11	2	2	8	11	8	5

KINGUA-FJORD.—One Year.
Lat. N. 66° 36′, Long. W. 67° 14′; Height, 30 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
8	8	11	5	6	3	3	3	8	1	6	3	4
6	6	12	3	4	6	2	4	8	1	4	2	4
4	7	10	1	3	4	3	5	4	2	3	2	3
2	1	6	0	3	1	5	8	4	0	0	2	0
2	0	8	4	6	1	4	8	4	1	3	1	1
2	0	4	4	7	3	8	8	1	2	3	3	2
0	0	0	5	10	5	9	8	8	4	4	3	4
4	3	3	3	11	5	7	6	4	4	4	3	3
0	2	3	4	12	5	7	6	7	5	6	1	4
2	3	7	7	11	4	4	2	7	7	6	0	3
5	3	7	3	7	1	1	3	3	12	6	0	0
7	0	5	1	2	5	3	9	2	12	1	2	3
13	4	0	2	1	8	3	11	5	12	0	3	6
8	4	2	2	2	5	6	9	3	8	2	1	4
0	1	2	2	3	3	7	8	1	4	2	1	2
5	5	5	2	2	2	8	10	2	3	3	4	0
8	8	6	4	4	0	7	9	3	7	5	5	2
7	8	11	3	4	1	9	8	5	13	6	6	3
8	8	7	0	5	3	6	5	5	12	4	8	3
4	7	4	1	5	3	4	2	2	12	2	5	2
8	4	2	0	5	2	1	1	1	11	0	4	2
7	2	1	3	5	3	1	3	2	9	7	1	1
2	5	2	6	9	0	0	4	4	7	10	6	2
5	8	7	6	9	2	1	4	4	5	11	4	3

UGLAAMIE.—Two Years.
Lat. N. 71° 23′, Long. W. 156° 40′; Height, 17 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	8	11	9	6	4	4	4	7	8	9	5	5	7
2 ,,	6	9	7	6	4	3	2	5	5	5	2	4	5
3 ,,	3	5	5	4	3	1	0	2	2	2	1	1	2
4 ,,	1	4	4	3	1	1	2	0	0	0	2	2	1
5 ,,	0	1	3	2	0	1	3	1	2	2	3	3	1
6 ,,	3	3	1	1	0	2	3	2	3	4	5	5	2
7 ,,	7	7	3	2	1	2	2	2	2	3	3	7	3
8 ,,	5	7	3	2	0	1	2	3	3	3	2	5	3
9 ,,	5	6	2	1	1	1	1	2	3	3	1	4	2
10 ,,	1	4	1	1	4	3	3	0	2	3	2	1	0
11 ,,	2	2	0	3	5	6	5	2	2	1	4	4	2
Noon	3	0	2	4	5	5	5	2	0	0	4	5	3
1 P.M.	4	1	4	3	4	4	4	1	0	1	2	3	2
2 ,,	2	1	2	1	3	4	4	1	1	1	1	1	2
3 ,,	1	0	1	0	1	2	2	1	1	2	2	1	0
4 ,,	1	0	1	0	1	2	2	0	1	2	2	1	0
5 ,,	1	1	2	1	2	0	1	2	2	3	2	1	1
6 ,,	1	2	4	5	7	3	3	3	2	0	1	1	2
7 ,,	2	1	5	7	8	5	5	5	2	1	1	1	3
8 ,,	3	6	9	9	7	5	8	6	4	3	4	2	6
9 ,,	3	3	6	9	6	9	6	3	4	0	2	1	4
10 ,,	3	1	3	5	5	8	4	1	1	2	1	0	2
11 ,,	2	1	1	3	3	4	2	2	3	5	0	1	0
Midt.	4	9	7	5	3	3	4	7	9	8	3	4	5

VAN RENSSELAER HARBOUR.—$1\frac{1}{2}$ Years.
Lat. N. 78° 37′, Long. W. 70° 35′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	8	17	14	9	2	2	14	2	11	1	2	1	2
2 ,,	9	18	9	6	2	3	10	1	7	3	3	6	0
3 ,,	5	22	6	4	4	1	7	0	1	2	14	5	1
4 ,,	·2	22	0	2	1	4	5	0	3	3	13	9	1
5 ,,	2	8	2	1	3	6	2	8	1	2	4	8	1
6 ,,	4	7	0	0	7	4	3	7	3	1	3	8	1
7 ,,	1	3	0	2	5	5	1	5	0	0	1	2	1
8 ,,	7	7	5	0	2	7	0	1	4	5	4	7	3
9 ,,	5	8	0	2	4	9	3	5	1	6	6	8	3
10 ,,	7	1	4	4	5	10	2	1	3	4	4	5	1
11 ,,	9	1	2	1	3	2	3	0	4	0	3	3	1
Noon	8	6	0	1	4	4	1	2	4	4	5	5	2
1 P.M.	8	12	4	7	6	0	11	4	3	0	11	13	6
2 ,,	7	6	4	8	3	0	13	5	3	3	12	13	6
3 ,,	7	7	5	4	3	0	12	8	1	3	11	10	4
4 ,,	6	8	2	1	2	3	6	8	2	0	5	9	2
5 ,,	3	17	4	1	2	5	0	4	2	4	6	0	0
6 ,,	1	17	5	3	6	6	3	5	7	3	2	5	2
7 ,,	1	19	07	6	2	2	1	4	6	5	0	2	3
8 ,,	4	15	12	10	2	4	2	4	7	8	1	6	4
9 ,,	9	14	8	8	2	2	4	1	7	6	2	4	5
10 ,,	14	12	5	7	4	1	6	1	5	4	7	8	6
11 ,,	12	15	4	4	6	1	3	3	1	0	3	7	4
Midt.	11	12	7	3	10	2	2	0	2	1	2	12	3

HUDSON STRAIT.—One Year.
Lat. N. 66° 32′, Long. W. 86° 56′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	11	10	3	0	6	3	13	10	4	2	9	13	2
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	13	6	2	6	0	1	10	4	2	1	8	11	1
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	12	1	1	4	2	4	6	6	2	0	4	16	1
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	6	0	1	1	5	0	4	4	0	0	1	19	1
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	9	8	1	1	4	0	1	9	12	3	1	10	3
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	1	7	0	0	7	5	3	10	10	3	0	15	4
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	8	6	10	4	10	5	3	5	8	0	4	10	5
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	4	2	4	3	8	2	5	1	4	3	4	6	1
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	6	9	3	7	4	0	5	1	3	2	0	23	2
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	4	13	5	11	7	3	8	4	8	8	1	25	5
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	10	10	4	5	12	3	4	4	10	4	6	24	4
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	15	5	1	7	13	2	3	4	10	3	12	20	1

On Board the "FOX."—One Year.
Lat. N. 72° 5′, Long. E. 65° 8′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	13	13	5	3	11	12	9	15	10	15	21	10	9
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	9	17	1	2	18	20	15	27	16	18	22	2	13
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	16	24	15	8	14	16	12	16	13	33	17	11	16
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	10	29	9	6	2	10	1	13	8	26	17	14	12
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	10	6	6	0	4	4	3	6	3	5	12	0	2
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	1	10	12	5	8	10	5	3	4	6	11	6	1
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	0	8	1	8	6	9	7	10	7	8	1	7	3
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	7	15	13	6	4	7	11	19	9	22	21	0	10
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	12	20	9	3	3	5	9	20	7	20	27	8	11
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	10	20	9	11	9	14	14	22	5	18	21	8	13
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	4	10	9	12	7	10	6	16	4	13	14	8	9
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	1	6	0	8	1	0	11	3	5	8	6	2	0

WELLINGTON CHANNEL.—One Year.
Lat. N. 75° 31′, Long. W. 92° 10′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	9	7	6	19	7	1	2	3	3	6	2	11	3
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	7	3	6	14	4	2	3	1	1	3	1	11	1
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	6	1	1	1	5	3	3	5	3	4	2	6	2
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	6	2	5	5	3	0	4	4	4	0	1	4	1
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	12	2	3	2	3	3	5	2	1	0	8	3	2
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	10	2	2	2	1	1	4	2	0	1	5	6	2
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	3	2	3	4	0	2	1	3	3	1	0	5	0
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	4	5	9	6	0	0	4	1	4	0	2	2	3
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	11	5	6	11	1	2	7	2	3	0	2	1	4
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	13	4	4	8	3	3	5	1	1	4	4	1	3
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	11	0	5	7	2	2	6	2	6	7	2	7	0
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	11	5	10	8	5	2	1	0	8	4	2	11	2

PORT LEOPOLD.—One Year.
Lat. N. 73° 50′, Long. W. 90° 12′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	22	0	0	7	7	2	2	3	3	9	6	7	4
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	25	0	9	7	8	5	3	1	11	14	6	3	8
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	21	3	16	11	9	6	3	1	4	13	6	7	9
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	7	5	4	8	2	4	1	0	2	0	6	1	1
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	12	17	4	14	7	3	0	4	11	22	15	10	9
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	19	14	6	9	5	3	2	7	10	20	5	10	9
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	14	7	1	7	1	2	0	1	9	5	2	4	3
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	9	4	5	0	3	1	1	3	4	3	5	9	2
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	7	6	0	1	1	1	3	5	1	2	2	3	1
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	2	10	3	0	3	3	2	3	3	0	0	4	1
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	7	6	7	3	5	4	3	1	1	0	8	4	2
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	9	8	3	5	3	0	5	2	5	7	6	3	0

GRIFFITH ISLAND.—One Year.
Lat. N. 74° 34′, Long. W. 95° 20′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	2	20	3	1	6	4	12	47	16	4	5	6	6
2 „	...	...	...	...	...	...	...	...	...	...	...	...	...
3 „	0	12	1	2	5	2	12	39	11	3	6	8	3
4 „	...	...	...	...	...	...	...	...	...	...	...	...	...
5 „	1	10	4	1	6	1	10	33	14	1	5	5	4
6 „	...	...	...	...	...	...	...	...	...	...	...	...	...
7 „	3	8	2	3	2	2	6	21	10	1	4	3	4
8 „	...	...	...	...	...	...	...	...	...	...	...	...	...
9 „	4	0	0	1	3	1	2	12	3	3	1	5	2
10 „	...	...	...	...	...	...	...	...	...	...	...	...	...
11 „	2	2	4	4	4	2	6	8	1	6	0	0	3
Noon	...	...	...	...	...	...	...	...	...	...	...	...	...
1 P.M.	2	1	6	6	1	2	9	5	3	6	4	2	2
2 „	...	...	...	...	...	...	...	...	...	...	...	...	...
3 „	2	2	1	3	1	1	8	22	6	1	4	3	2
4 „	...	...	...	...	...	...	...	...	...	...	...	...	...
5 „	8	9	4	3	1	3	2	27	7	4	6	3	6
6 „	...	...	...	...	...	...	...	...	...	...	...	...	...
7 „	6	11	8	7	5	0	4	35	14	4	7	7	7
8 „	...	...	...	...	...	...	...	...	...	...	...	...	...
9 „	3	12	2	7	0	1	4	33	17	2	3	11	5
10 „	...	...	...	...	...	...	...	...	...	...	...	...	...
11 „	5	10	2	4	7	2	4	35	12	4	3	17	2
Midt.	...	...	...	...	...	...	...	...	...	...	...	...	...

PRINCESS ROYAL.—One Year.
Lat. N. 72° 50′, Long. W. 117° 55′; Height, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	16	11	11	7	2	1	3	7	9	8	10	8	2
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	10	2	5	9	5	4	4	9	3	10	8	7	4
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	8	7	14	5	3	0	0	9	3	11	3	8	5
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	2	3	8	3	4	1	1	7	4	6	5	3	2
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	5	1	7	6	2	1	2	7	3	2	5	4	0
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	9	10	2	2	2	1	5	5	6	4	5	10	2
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 „	9	10	5	5	1	2	7	3	7	10	1	3	2
3 „	...	...	...	...	...	...	...	...	...	...	...	...	...
4 „	2	5	5	5	1	0	4	3	5	9	3	1	1
5 „	...	...	...	...	...	...	...	...	...	...	...	...	...
6 „	4	1	3	2	2	1	1	10	3	4	12	0	1
7 „	...	...	...	...	...	...	...	...	...	...	...	...	...
8 „	1	2	9	3	6	4	5	11	0	4	14	1	2
9 „	...	...	...	...	...	...	...	...	...	...	...	...	...
10 „	7	6	11	7	4	2	8	11	0	5	0	7	5
11 „	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	11	13	7	9	3	1	8	10	6	0	5	1	2

MERCY BAY.—1⅔ YEARS, 1851–53.
LAT. N. 74° 6′, LONG. W. 117° 55′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	10	11	9	7	14	6	9	2	6	1	0	15	4
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	12	8	9	3	14	5	7	6	9	2	0	14	5
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	12	7	12	5	12	3	5	1	5	5	1	12	5
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	7	8	8	1	9	2	2	2	1	3	4	9	2
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	8	8	5	1	6	1	0	1	3	2	3	1	1
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	0	7	1	4	2	5	2	3	2	1	6	6	2
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	1	2	2	5	7	3	3	5	1	1	5	5	2
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	3	3	3	5	8	1	7	3	3	1	0	7	1
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	7	2	4	6	10	2	8	2	2	6	3	8	3
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	10	8	9	6	10	2	5	6	6	4	4	8	4
9 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
10 ,,	16	13	13	2	9	5	3	11	3	2	1	9	5
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	8	18	11	7	6	0	1	9	8	4	5	7	1

CAMISSO ISLAND.—ONE YEAR.
LAT. N. 66° 13′, LONG. W. 161° 46′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	26	1	9	0	4	9	2	8	21	7	11	7
2 ,,	5	22	1	10	3	3	8	4	6	17	5	9	6
3 ,,	3	17	4	11	4	0	4	5	2	12	4	9	5
4 ,,	0	11	5	10	6	1	2	4	1	7	4	11	3
5 ,,	1	9	4	7	8	0	0	6	2	5	1	11	4
6 ,,	3	9	5	4	6	1	4	7	4	0	0	7	2
7 ,,	11	2	7	0	4	5	7	12	5	1	4	2	1
8 ,,	17	2	11	0	2	3	7	11	6	4	5	7	2
9 ,,	21	2	10	4	12	2	6	17	7	7	10	7	1
10 ,,	17	4	5	4	11	4	8	15	7	5	5	8	1
11 ,,	14	3	2	9	12	4	10	17	7	5	3	7	2
Noon	9	3	0	8	11	4	10	11	5	7	3	8	1
1 P.M.	13	3	2	4	6	0	8	4	8	3	3	6	0
2 ,,	9	5	2	1	3	1	5	2	2	1	4	4	1
3 ,,	3	9	2	4	0	2	2	1	0	4	4	6	3
4 ,,	0	10	4	7	3	3	1	4	6	3	6	9	5
5 ,,	6	8	3	11	6	1	4	10	11	14	7	2	6
6 ,,	6	9	2	13	6	3	5	15	14	16	6	5	8
7 ,,	10	13	0	15	12	5	11	17	13	13	10	10	9
8 ,,	12	10	4	8	11	5	10	17	12	10	5	9	7
9 ,,	16	11	8	3	11	7	12	18	8	1	4	4	4
10 ,,	17	12	13	5	10	2	7	13	6	2	9	3	1
11 ,,	20	5	15	6	10	1	2	15	4	8	16	9	1
Midt.	19	5	17	2	8	5	3	15	3	13	20	15	5

PORT PROVIDENCE.—¾ YEAR.
LAT. N. 64° 26′, LONG. W. 173° 0′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	7	13	7	3	11	6	...	...	...	5	2	28	...
2 ,,	5	11	3	7	12	5	...	...	...	0	3	25	...
3 ,,	1	8	3	7	13	8	...	...	...	0	6	20	...
4 ,,	4	8	2	10	12	9	...	...	...	7	6	14	...
5 ,,	6	1	3	9	10	7	...	...	...	5	6	7	...
6 ,,	11	1	2	8	9	7	...	...	...	3	4	1	...
7 ,,	9	0	4	3	10	4	...	...	...	1	3	3	...
8 ,,	16	0	5	0	10	2	...	...	...	4	5	10	...
9 ,,	15	13	3	4	6	1	...	...	...	7	4	12	...
10 ,,	1	8	11	2	9	4	...	...	...	12	0	3	...
11 ,,	2	7	16	2	5	5	...	...	...	10	1	3	...
Noon	3	10	12	5	7	4	...	...	...	16	1	1	...
1 P.M.	0	13	1	4	2	4	...	...	...	17	6	1	...
2 ,,	1	13	1	1	0	4	...	...	...	16	6	6	...
3 ,,	3	10	1	2	4	6	...	...	...	13	6	9	...
4 ,,	2	8	0	2	4	4	...	...	...	9	0	10	...
5 ,,	1	8	6	3	7	2	...	...	...	6	4	10	...
6 ,,	4	6	1	10	14	1	...	...	...	10	2	8	...
7 ,,	4	2	5	11	17	2	...	...	...	6	1	10	...
8 ,,	4	7	6	8	21	4	...	...	...	19	4	5	...
9 ,,	4	8	3	2	20	4	...	...	...	24	10	5	...
10 ,,	10	10	0	17	16	2	...	...	...	24	15	6	...
11 ,,	10	14	2	28	15	3	...	...	...	29	17	2	...
Midt.	9	15	0	27	8	4	...	...	...	35	17	6	...

PORT CLARENCE.—ONE YEAR.
LAT. N. 65° 5′, LONG. W. 165° 30′; HEIGHT, 0 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	25	17	23	11	3	0	23	...	5	16	1	3	...
2 ,,	23	12	22	10	7	0	21	...	9	16	1	1	...
3 ,,	20	8	18	14	4	1	17	...	7	15	2	1	...
4 ,,	14	4	13	15	4	4	13	...	7	14	2	0	...
5 ,,	10	4	14	15	8	4	14	...	3	16	0	3	...
6 ,,	4	13	9	12	6	4	13	...	2	15	1	4	...
7 ,,	1	15	0	7	3	3	9	...	0	12	1	2	...
8 ,,	8	20	6	4	1	1	6	...	1	6	7	2	...
9 ,,	9	18	10	11	3	0	2	...	0	3	13	3	...
10 ,,	9	17	10	3	1	0	3	...	2	2	10	2	...
11 ,,	7	8	5	2	2	1	7	...	6	0	11	2	...
Noon	7	3	5	3	0	1	4	...	6	4	12	0	...
1 P.M.	8	6	12	6	2	1	6	...	3	1	10	2	...
2 ,,	11	8	9	6	2	1	2	...	4	7	10	3	...
3 ,,	12	8	12	8	1	0	3	...	6	7	6	3	...
4 ,,	8	3	15	10	2	1	8	...	7	9	6	3	...
5 ,,	8	2	16	11	4	0	11	...	10	15	6	5	...
6 ,,	6	1	17	16	9	1	13	...	15	20	0	4	...
7 ,,	6	2	13	18	8	0	19	...	10	16	4	3	...
8 ,,	5	12	5	15	7	5	20	...	9	17	10	0	...
9 ,,	2	18	2	6	6	4	19	...	2	13	15	0	...
10 ,,	0	15	7	6	3	0	17	...	3	9	20	5	...
11 ,,	1	18	11	14	3	3	13	...	6	4	28	10	...
Midt.	1	18	12	19	5	5	15	...	9	0	32	16	...

ADDENDA

TO TABLE IV.

ST. MARTIN-DE-HINX.—TWENTY YEARS.
LAT. N. 43° 35′, LONG. W. 1° 36′; HEIGHT, 131 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	4	5	6	6	7	7	8	7	4	2	2	4	5
2 ,,	0	0	1	1	0	2	2	1	3	4	2	1	1
3 ,,	6	8	8	7	5	2	3	6	9	10	7	6	6
4 ,,	12	13	15	10	6	5	6	9	14	15	12	11	12
5 ,,	14	14	12	8	3	2	4	8	12	14	13	13	10
6 ,,	9	9	6	2	1	1	0	2	5	6	7	8	4
7 ,,	1	2	0	3	4	5	4	3	2	1	1	0	2
8 ,,	8	7	7	7	8	8	8	7	8	9	9	9	8
9 ,,	15	14	13	10	9	8	9	11	15	17	16	16	13
10 ,,	17	18	16	11	9	7	8	11	17	18	18	18	14
11 ,,	11	14	13	8	6	4	4	6	10	11	9	10	10
Noon	1	5	5	2	1	0	0	2	3	1	1	1	2
1 P.M.	8	5	4	4	5	5	5	4	5	8	12	11	6
2 ,,	15	15	12	11	11	11	10	11	12	16	20	17	13
3 ,,	16	21	20	18	17	16	16	17	19	19	19	16	18
4 ,,	13	18	21	23	22	21	21	22	21	17	13	12	19
5 ,,	7	11	17	21	22	22	21	21	17	10	6	6	15
6 ,,	2	4	8	13	16	16	15	13	9	2	0	0	8
7 ,,	4	2	0	4	7	8	7	5	0	4	6	5	1
8 ,,	7	7	7	5	4	2	2	4	8	9	9	8	6
9 ,,	9	11	14	14	13	11	11	12	14	14	11	9	12
10 ,,	9	14	19	21	19	18	19	20	17	15	12	10	16
11 ,,	9	13	17	19	20	19	19	19	16	13	10	9	15
Midt.	8	9	11	13	14	13	14	14	11	8	7	7	11

IRKUTSH.—ONE YEAR.
LAT. N. 52° 17′, LONG. E. 104° 19′; HEIGHT, 1611 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	0	6	0	21	13	7	8	6	4	3	2	11	5
2 ,,	0	7	4	21	11	11	8	6	0	4	0	9	5
3 ,,	2	5	4	21	14	15	8	6	2	1	7	6	5
4 ,,	1	2	4	19	14	22	15	8	5	1	10	7	5
5 ,,	3	1	9	17	20	26	18	10	5	2	10	7	6
6 ,,	2	4	15	25	27	30	25	17	5	6	11	3	11
7 ,,	9	11	22	28	34	31	29	18	13	15	6	2	17
8 ,,	18	19	26	36	36	32	31	17	20	21	4	8	22
9 ,,	22	25	27	31	32	26	28	17	26	26	10	16	24
10 ,,	20	18	21	21	25	19	23	10	26	23	9	18	19
11 ,,	13	16	11	13	12	13	17	4	17	15	7	12	12
Noon	1	5	1	6	2	2	5	5	4	1	1	1	1
1 P.M.	9	4	11	19	11	11	7	13	7	11	7	10	10
2 ,,	18	14	22	29	23	22	22	22	19	18	11	13	19
3 ,,	17	21	29	39	38	34	32	28	26	17	12	11	25
4 ,,	12	24	33	46	40	38	38	31	27	13	6	7	26
5 ,,	8	21	32	45	45	44	40	26	23	9	1	3	25
6 ,,	3	15	23	41	42	36	33	20	17	1	4	0	19
7 ,,	0	6	11	33	35	30	22	17	11	7	6	3	12
8 ,,	3	2	3	10	19	18	16	2	0	9	9	5	4
9 ,,	0	1	2	1	6	6	1	6	4	7	8	4	2
10 ,,	0	0	4	2	2	1	2	10	8	9	10	5	4
11 ,,	2	2	7	6	7	3	4	16	9	8	5	6	6
Midt.	6	3	9	8	11	7	1	20	9	6	5	6	6

JACOBABAD.—Lat. N. 28° 19′, Long. E. 68° 24′; Jan. and Feb.
AHMEDNUGGER.—Lat. N. 19° 6′, Long. E. 74° 16′; April to Aug.

	Jan.	Feb.		April.	May.	June.	July.	Aug.					
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	...	...	...	40	31	24	13	10	...	...	...	...	...
7 ,,	53	70	...	56	48	34	25	23	...	...	...	...	...
8 ,,	77	87	...	77	62	46	37	36	...	...	...	...	...
9 ,,	88	97	...	74	62	49	43	45	...	...	...	...	...
10 ,,	75	85	...	57	54	43	41	43	...	...	...	...	...
11 ,,	43	55	...	44	42	33	36	36	...	...	...	...	...
Noon	2	8	...	25	19	18	16	14	...	...	...	...	...
1 P.M.	35	32	...	4	6	5	8	5	...	...	...	...	...
2 ,,	63	64	...	43	33	27	21	27	...	...	...	...	...
3 ,,	72	86	...	60	57	47	39	42	...	...	...	...	...
4 ,,	78	90	...	79	71	61	50	52	...	...	...	...	...
5 ,,	69	76	...	80	68	48	47	45	...	...	...	...	...
6 ,,	40	51	...	61	53	35	32	26	...	...	...	...	...
7 ,,	7	24	...	45	31	11	10	5	...	...	...	...	...
8 ,,	9	2	...	14	10	11	7	15	...	...	...	...	...
9 ,,	36	29	...	0	12	28	25	31	...	...	...	...	...
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	...	...	...	...	...	...	...	...	...	...	...	...	...

M' BOMA.
Lat. S. 5° 47′, Long. E. 13° 11′; Height, 80 Feet.

	Jan.	Feb.	Mar.								Nov.	Dec.	Period
	12	12	18	...	...	...	...	...	...	...	17	7	13
	11	1	13	...	...	...	...	...	...	...	5	2	5
	1	1	2	...	...	...	...	...	...	...	2	7	1
	5	6	2	...	...	...	...	...	...	...	0	7	0
	16	10	3	...	...	...	...	...	...	...	5	5	8
	28	20	12	...	...	...	...	...	...	...	13	24	19
	43	33	30	...	...	...	...	...	...	...	20	40	33
	51	41	50	...	...	...	...	...	...	...	57	51	50
	55	47	54	...	...	...	...	...	...	...	65	55	55
	53	40	44	...	...	...	...	...	...	...	59	43	49
	36	28	39	...	...	...	...	...	...	...	48	38	38
	10	18	3	...	...	...	...	...	...	...	16	17	13
	8	8	15	...	...	...	...	...	...	...	15	12	20
	31	47	42	...	...	...	...	...	...	...	50	36	41
	64	68	75	...	...	...	...	...	...	...	58	48	63
	67	69	84	...	...	...	...	...	...	...	91	67	76
	56	53	69	...	...	...	...	...	...	...	89	60	65
	52	37	45	...	...	...	...	...	...	...	63	52	50
	44	21	24	...	...	...	...	...	...	...	35	40	33
	13	1	2	...	...	...	...	...	...	...	6	13	4
	4	15	22	...	...	...	...	...	...	...	10	7	12
	17	16	26	...	...	...	...	...	...	...	37	23	24
	20	18	24	...	...	...	...	...	...	...	35	31	26
	13	13	23	...	...	...	...	...	...	...	29	16	21

CONSTANTINOPLE—One Year.
Lat. N. 41° 0′, Long. E. 28° 59′; Height, ? Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	12	11	11	1	3	0	2	3	4	3	6	5	4
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	12	14	17	18	12	11	6	9	10	16	15	11	12
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	4	8		9	2	5	4	6	3	4	2	3	4
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	12	14	17	17	12	11	5	9	10	16	18	11	13
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	4	17	16	18	14	16	8	16	5	11	8	3	11
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	3	10	6	4	6	2	4	5	4	2	3	1	2
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	...	...	...	...	...	...	...	...	...	...	...	...	...

SENFTENBERG.—Ten Years.
Lat. N. 50° 5′, Long. E. 16° 25′; Height, 1381 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	5	7	0	0	0	2	4	1	4	4	1	9	2
	5	6	3	1	3	4	2	2	1	1	4	5	0
	3	4	6	1	3	1	1	1	1	1	6	2	1
	5	1	9	2	2	0	0	1	3	3	9	2	3
	4	3	11	0	3	2	0	1	4	2	9	5	3
	3	5	8	2	0	7	3	3	2	1	9	8	2
	2	4	3	7	4	9	6	7	0	6	7	7	2
	7	1	0	8	6	10	5	8	1	10	3	5	4
	14	2	2	9	8	12	7	8	4	12	2	1	7
	16	2	6	10	9	12	3	9	10	14	5	4	9
	14	5	7	9	7	10	7	8	9	13	4	5	8
	5	1	5	5	6	6	4	4	7	8	0	1	4
	3	7	3	0	1	1	1	1	2	2	5	4	1
	11	11	3	6	5	5	4	4	3	6	8	9	6
	10	11	4	8	5	5	4	5	5	10	6	7	7
	10	9	7	11	8	10	8	8	5	12	4	5	8
	11	7	6	12	12	12	11	10	7	12	2	4	9
	7	2	3	11	10	12	11	10	6	9	2	1	7
	4	3	2	8	6	12	10	9	3	6	6	2	4
	4	4	6	2	1	9	7	4	1	4	8	3	1
	3	5	8	2	1	4	2	1	4	1	11	6	3
	1	7	11	3	5	2	0	4	5	4	14	7	4
	1	7	10	5	5	0	1	6	5	4	12	5	5
	5	8	5	0	2	1	6	2	6	5	5	13	4

NAMUR.—$6\frac{1}{2}$ Years.
Lat. N. 50° 28′, Long, E. 4° 51′; Height, 491 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	11	2	4	3	2	2	1	4	1	1	0	0	2
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	...	5	5	8	2	3	4	1	5	6	5	4	4
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	6	4	2	3	7	2	2	5	0	3	5	6	1
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	1	6	8	3	13	8	8	12	10	11	1	1	7
9 ,,	6	8	9	8	13	10	6	11	12	14	11	6	10
10 ,,	9	10	8	7	12	7	5	8	12	14	13	1	9
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	0	5	4	2	3	0	2	0	4	4	1	2	2
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	17	10	7	4	7	4	4	11	9	11	16	13	9
3 ,,	18	17	14	16	14	11	8	17	15	17	17	12	15
4 ,,	15	16	16	14	21	13	11	18	18	19	15	8	15
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	6	5	13	4	18	16	12	18	13	7	3	3	10
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	4	4	0	8	5	1	2	9	3	0	5	7	1
9 ,,	5	11	4	13	7	12	7	3	11	6	12	12	9
10 ,,	4	9	2	14	10	14	10	6	10	4	8	12	9
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	12	5	10	5	9	8	8	11	8	6	12	8	8

DUBLIN.—$3\frac{2}{3}$ Years.
Lat. N. 53° 22′, Long. W. 6° 21′; Height, 162 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	11	2	2	3	10	3	5	4	8	7	1	10	0
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	10	7	10	12	1	7	6	12	19	12	9	5	7
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	9	13	9	13	2	0	0	3	13	12	22	16	9
6 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,,	6	7	4	0	6	7	8	6	2	7	12	10	1
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	8	11	4	3	8	9	8	11	6	19	2	6	8
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	8	16	7	2	4	6	3	7	6	18	6	7	7
Noon	...	...	...	...	...	...	...	...	...	...	...	...	...
1 P.M.	9	1	3	1	1	3	2	2	3	3	2	6	1
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	14	8	13	7	10	5	10	5	4	7	6	8	8
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	6	7	6	7	14	12	14	10	3	7	2	0	7
6 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,,	1	6	3	2	12	10	8	7	7	2	8	4	1
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	7	6	14	14	2	0	7	16	12	2	16	13	8
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	1	2	19	16	3	2	11	8	11	8	21	21	9
Midt.	...	...	...	...	...	...	...	...	...	...	...	...	...

CHRISTIANSAND.—Two Years.
Lat. N. 58° 8′, Long. W. 8° 0′; Height, ? Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	3	6	0	9	1	3	0	2	4	6	5	7	1
2 ,,	2	5	4	7	1	3	1	6	2	9	7	9	1
3 ,,	3	4	7	4	3	2	1	7	7	10	9	8	2
4 ,,	4	2	10	1	6	3	1	8	9	9	9	5	3
5 ,,	6	1	11	2	9	4	0	7	9	7	8	1	3
6 ,,	6	2	10	3	11	7	2	5	6	4	6	3	2
7 ,,	3	1	7	4	11	10	4	2	2	1	1	4	0
8 ,,	3	2	2	2	7	12	5	0	2	2	5	3	2
9 ,,	7	6	2	1	4	13	6	4	5	4	11	2	5
10 ,,	10	9	5	0	1	12	7	7	6	6	15	1	6
11 ,,	10	9	5	1	1	10	6	9	6	6	16	2	6
Noon	7	6	4	0	2	7	6	11	5	6	13	3	5
1 P.M.	2	0	1	2	3	2	5	10	3	6	6	5	2
2 ,,	3	6	2	5	5	2	3	7	1	6	1	6	1
3 ,,	6	11	3	7	7	7	0	3	2	5	6	4	4
4 ,,	5	14	2	8	10	11	3	2	4	4	9	2	5
5 ,,	2	13	0	8	12	14	6	6	6	2	9	0	6
6 ,,	2	9	3	6	11	16	8	7	6	1	5	2	5
7 ,,	4	5	5	2	8	15	9	5	4	0	0	2	3
8 ,,	3	1	7	1	4	12	8	2	2	0	3	1	1
9 ,,	1	2	8	4	0	8	5	1	3	1	4	2	1
10 ,,	2	3	8	7	3	4	2	2	7	0	3	2	2
11 ,,	3	4	6	9	4	0	0	3	9	1	1	0	3
Midt.	7	5	4	9	2	2	0	1	7	3	2	4	2

DORPAT.— ? Years.
Lat. N. 58° 23′, Long. E. 26° 43′; Height, 223 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,,	5	5	1	2	4	7	6	6	3	6	7	8	1
8 ,,	3	3	2	3	6	9	6	7	0	3	4	4	1
9 ,,	0	0	3	5	6	9	8	8	3	1	0	0	4
10 ,,	3	1	4	5	7	8	8	8	5	3	3	3	5
11 ,,	3	2	3	4	6	7	6	8	5	4	3	3	5
Noon	0	0	2	3	4	5	4	6	4	3	1	0	3
1 P.M.	2	1	1	1	2	1	1	2	2	1	1	3	0
2 ,,	4	2	2	2	1	3	3	3	1	1	3	5	3
3 ,,	3	3	3	4	4	6	6	6	4	3	5	3	4
4 ,,	2	1	4	5	7	9	8	8	5	3	2	2	5
5 ,,	0	2	3	6	9	10	9	10	5	2	0	0	4
6 ,,	0	5	0	4	9	11	8	9	3	1	1	0	3
7 ,,	2	8	4	0	6	9	6	6	0	2	1	0	1
8 ,,	3	9	7	4	2	6	2	2	3	3	2	2	2
9 ,,	4	11	9	7	3	2	2	2	4	4	2	3	4
10 ,,	4	12	9	8	6	2	7	4	5	5	3	4	6
11 ,,	4	12	8	8	7	4	9	5	5	4	2	4	6
Midt.	...	...	...	...	...	...	...	...	...	...	...	...	...

CAPE BORDA.
Lat. N. 35° 45′, Long. E. 136° 35′; Height, 506 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	26	30	17	14	10	4	3	18	13	32	35	22	19
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	7	7	8	6	1	2	1	0	3	7	7	1	3
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	17	24	20	24	15	24	17	20	15	20	7	17	18
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Noon	10	9	6	8	9	4	15	2	14	2	4	8	0
1 P.M.	...	...	...	...	...	...	...	...	...	...	...	...	...
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	9	9	21	22	17	18	21	18	24	9	7	16	16
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
6 ,,	5	2	6	12	1	12	3	6	3	10	11	2	0
7 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	9	19	24	16	18	2	20	15	25	24	19	13	17
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
Midt.	9	7	0	4	5	8	7	4	12	5	4	1	0
1878	·079	·067	·099	079	·183	·082	·000	·056	·924	·946	·028	·936	·040

MOUNT WASHINGTON.—One Month, June.
Lat. N. 44° 16′, Long. W. 71° 18′.

2898 Feet.	4059 Feet.	5533 Feet.	6285 Feet.
1	4	7	4
3	8	9	8
6	10	14	16
1	4	15	20
9	1	9	17
15	4	6	11
20	10	2	5
21	13	5	1
20	15	10	6
19	16	14	13
14	14	13	18
6	9	13	19
1	5	11	17
8	1	8	12
15	5	6	8
18	10	1	3
20	14	5	4
18	13	5	3
11	7	2	1
8	3	0	1
3	1	3	4
4	0	3	1
5	2	0	1
7	5	6	3

VAMDRUP.—Eleven Years.
Lat. N. 55° 25′, Long. E. 9° 18′; Height, 131 Feet.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 A.M.	5	6	2	4	3	4	10	7	2	2	3	2	3
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	8	2	8	5	5	6	3	4	9	6	4	5	5
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	12	1	9	8	7	7	7	7	14	13	11	11	9
6 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,,	9	3	5	2	2	2	4	6	9	11	4	8	5
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	2	4	4	5	5	1	0	1	2	3	5	1	2
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	8	6	8	5	4	1	1	1	5	8	7	7	5
Noon	...	...	...	...	...	...	...	...	...	...	...	...	...
1 P.M.	2	2	5	2	0	2	2	1	3	4	1	1	2
2 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
3 ,,	4	8	4	9	6	2	3	4	3	4	7	6	5
4 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ,,	1	6	6	10	10	7	7	5	4	2	3	1	5
6 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
7 ,,	6	1	2	2	4	3	3	1	4	7	3	6	1
8 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
9 ,,	8	1	8	11	11	7	6	9	11	11	7	8	8
10 ,,	...	...	...	...	...	...	...	...	...	...	...	...	...
11 ,,	6	1	7	10	10	9	9	9	11	8	3	7	7
Midt.	...	...	...	...	...	...	...	...	..	...	...	...	...

RIO JANEIRO.—One and a Half Years.
Lat. S. 22° 57′, Long. W. 43° 7′; Height, 224 Feet.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
4	14	15	10	2	12	11	4	8	7	3	0	8
9	4	10	1	4	6	3	3	3	7	11	9	2
10	15	17	10	17	5	9	12	17	16	15	11	13
18	17	23	12	21	9	14	14	19	19	11	11	16
8	14	16	10	19	9	15	12	11	9	2	7	11
4	1	5	4	7	0	9	3	3	8	12	11	2
22	14	8	24	11	14	8	8	14	22	25	18	16
26	24	16	34	28	27	24	37	28	38	39	31	29
41	28	32	38	37	38	44	40	38	48	38	33	38
39	32	33	40	39	43	45	41	34	39	28	29	37
21	24	20	22	24	32	35	36	22	24	13	20	24
4	4	2	7	2	9	17	5	7	5	6	1	4
7	9	17	26	23	21	13	13	26	22	21	12	18
24	26	38	49	41	40	37	38	41	38	35	37	37
40	43	48	54	49	44	52	43	50	49	47	39	46
47	49	48	52	46	45	45	40	49	50	51	41	47
45	44	34	39	35	40	38	33	38	40	39	38	39
34	32	24	26	26	31	27	28	21	25	26	29	27
18	17	10	13	7	20	11	14	3	9	7	11	12
5	4	12	5	11	8	1	5	14	9	13	8	8
14	26	28	14	22	22	13	10	25	25	27	23	21
24	37	36	22	28	30	21	22	26	31	38	35	29
26	36	34	22	28	25	23	21	28	21	34	33	28
19	24	29	18	23	14	19	20	20	19	27	21	21

TABLE V.

FOR REDUCING OBSERVATIONS OF THE BAROMETER TO SEA-LEVEL (CONSTRUCTED FOR LATITUDE 45° AND A SEA-LEVEL PRESSURE OF 30 INCHES).

CHALLENGER REPORTS.

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
10	·013	·013	·012	·012	·012	·012	·011	·011	·011	·011	·010	·010
20	·026	·025	·025	·024	·023	·023	·023	·022	·022	·021	·021	·020
30	·038	·037	·036	·036	·035	·034	·034	·033	·032	·032	·031	·031
40	·051	·049	·048	·047	·046	·046	·045	·044	·043	·042	·041	·041
50	·063	·061	·060	·059	·058	·057	·056	·055	·054	·053	·053	·052
60	·075	·074	·073	·071	·069	·068	·067	·066	·065	·063	·063	·062
70	·088	·086	·084	·083	·081	·080	·078	·077	·076	·075	·073	·072
80	·101	·099	·096	·095	·093	·092	·090	·088	·086	·085	·083	·082
90	·114	·111	·109	·107	·104	·103	·101	·099	·097	·096	·094	·092
100	·126	·123	·121	·118	·116	·114	·112	·110	·108	·106	·104	·103
110	·139	·136	·133	·130	·128	·125	·123	·121	·119	·117	·114	·113
120	·151	·148	·145	·142	·139	·137	·134	·132	·130	·128	·125	·123
130	·164	·161	·157	·154	·151	·148	·146	·143	·141	·138	·135	·133
140	·177	·173	·169	·166	·163	·160	·157	·154	·151	·148	·146	·144
150	·189	·185	·181	·178	·174	·171	·168	·165	·162	·159	·156	·154
160	·201	·197	·194	·190	·186	·182	·179	·176	·173	·169	·167	·165
170	·214	·210	·206	·201	·197	·194	·190	·187	·184	·181	·178	·175
180	·227	·222	·218	·213	·209	·205	·202	·198	·195	·191	·188	·185
190	·239	·234	·230	·225	·220	·217	·213	·209	·205	·202	·199	·195
200	·252	·247	·242	·237	·232	·228	·224	·220	·216	·212	·209	·205
210	·265	·259	·254	·249	·244	·239	·235	·231	·227	·223	·219	·216
220	·277	·272	·266	·261	·255	·251	·246	·242	·237	·233	·230	·226
230	·289	·284	·278	·273	·267	·262	·257	·253	·248	·244	·240	·236
240	·302	·296	·290	·284	·279	·273	·269	·264	·259	·254	·251	·246
250	·315	·308	·302	·296	·290	·285	·280	·275	·270	·265	·261	·257
260	·327	·320	·314	·307	·301	·296	·291	·285	·280	·276	·271	·267
270	·340	·332	·325	·319	·313	·307	·302	·296	·291	·287	·281	·277
280	·354	·345	·338	·331	·325	·319	·314	·307	·302	·297	·292	·288
290	·367	·357	·350	·343	·336	·330	·325	·318	·313	·308	·303	·298
300	·380	·370	·362	·355	·348	·341	·336	·329	·324	·318	·313	·308
310	·390	·382	·374	·367	·360	·352	·347	·340	·335	·329	·323	·318
320	·402	·394	·386	·378	·371	·364	·358	·351	·345	·339	·333	·328
330	·415	·406	·398	·390	·383	·375	·368	·362	·356	·350	·344	·339
340	·427	·419	·410	·402	·394	·387	·380	·373	·367	·360	·354	·349
350	·440	·431	·422	·414	·406	·398	·391	·385	·378	·371	·365	·359
360	·452	·442	·434	·425	·417	·409	·402	·395	·388	·381	·375	·369
370	·465	·454	·446	·437	·428	·421	·413	·406	·399	·392	·386	·379
380	·477	·467	·458	·449	·440	·432	·424	·417	·410	·403	·396	·389
390	·490	·479	·470	·460	·451	·444	·435	·428	·420	·414	·406	·399
400	·502	·491	·481	·472	·463	·455	·446	·439	·431	·424	·416	·410
410	·516	·503	·493	·484	·475	·466	·457	·450	·442	·434	·426	·419
420	·527	·516	·505	·496	·486	·478	·468	·461	·453	·445	·437	·429
430	·539	·528	·517	·507	·498	·489	·479	·471	·463	·455	·447	·440
440	·552	·540	·529	·519	·510	·500	·490	·482	·474	·466	·458	·450
450	·565	·552	·541	·531	·521	·510	·502	·493	·485	·476	·468	·460
460	·577	·564	·553	·542	·532	·522	·513	·504	·496	·487	·478	·470
470	·589	·577	·565	·554	·543	·533	·524	·515	·506	·497	·488	·480
480	·602	·589	·577	·565	·555	·544	·535	·525	·517	·507	·499	·490
490	·614	·601	·588	·577	·565	·555	·546	·536	·527	·518	·509	·499
500	·626	·613	·600	·589	·577	·567	·557	·547	·538	·529	·520	·509
510	·639	·625	·612	·600	·589	·578	·568	·558	·548	·539	·530	·520
520	·651	·637	·624	·612	·601	·590	·579	·569	·559	·550	·540	·531
530	·663	·650	·636	·623	·612	·601	·590	·579	·569	·560	·550	·541
540	·675	·662	·648	·635	·623	·612	·601	·590	·580	·570	·561	·551
550	·688	·674	·660	·647	·635	·623	·612	·601	·590	·581	·571	·562
560	·700	·686	·672	·659	·646	·635	·623	·612	·601	·591	·581	·572
570	·712	·699	·685	·671	·658	·647	·634	·622	·612	·602	·592	·582
580	·724	·711	·697	·683	·671	·658	·645	·633	·623	·613	·603	·593
590	·736	·722	·708	·694	·682	·669	·656	·644	·633	·623	·613	·603
600	·749	·734	·719	·705	·692	·679	·667	·655	·644	·633	·623	·613

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
600	·749	·734	·719	·705	·692	·679	·667	·655	·644	·633	·623	·613
610	·762	·746	·731	·717	·703	·690	·678	·666	·654	·643	·633	·624
620	·774	·759	·743	·729	·715	·701	·689	·676	·665	·654	·643	·634
630	·787	·771	·755	·740	·726	·713	·700	·687	·675	·664	·653	·644
640	·799	·783	·767	·752	·737	·724	·711	·698	·686	·675	·664	·654
650	·811	·795	·779	·763	·748	·735	·722	·709	·696	·685	·674	·664
660	·823	·807	·791	·775	·759	·746	·733	·720	·707	·696	·685	·674
670	·835	·819	·802	·786	·770	·757	·744	·730	·717	·706	·696	·684
680	·848	·831	·814	·798	·782	·769	·755	·741	·728	·717	·706	·694
690	·860	·843	·826	·810	·794	·780	·766	·751	·738	·726	·714	·703
700	·873	·855	·838	·822	·806	·791	·777	·762	·749	·737	·725	·713
710	·885	·866	·850	·833	·817	·802	·788	·772	·759	·748	·735	·723
720	·897	·878	·861	·844	·828	·813	·799	·783	·770	·758	·745	·733
730	·909	·891	·873	·856	·840	·825	·810	·794	·781	·768	·756	·744
740	·921	·903	·885	·868	·851	·837	·821	·805	·791	·778	·766	·754
750	·933	·914	·897	·880	·861	·847	·831	·816	·802	·789	·777	·764
760	·945	·926	·909	·892	·872	·858	·841	·826	·812	·799	·787	·774
770	·957	·938	·921	·904	·884	·869	·852	·838	·823	·809	·797	·784
780	·969	·951	·933	·915	·895	·881	·863	·849	·833	·819	·808	·794
790	·982	·963	·944	·926	·907	·891	·874	·860	·844	·830	·818	·804
800	·995	·975	·955	·937	·919	·902	·885	·870	·855	·840	·828	·814
810	1·007	·986	·966	·928	·930	·913	·896	·881	·865	·851	·838	·824
820	1·019	·998	·978	·960	·942	·924	·907	·891	·876	·862	·848	·834
830	1·031	1·011	·990	·972	·953	·935	·918	·902	·886	·872	·858	·844
840	1·043	1·023	1·002	·983	·964	·946	·929	·913	·897	·882	·868	·854
850	1·055	1·034	1·013	·996	·975	·958	·940	·923	·908	·892	·878	·864
860	1·068	1·046	1·025	1·006	·986	·969	·950	·934	·918	·903	·888	·874
870	1·080	1·058	1·036	1·017	·998	·980	·961	·945	·929	·913	·898	·884
880	1·092	1·070	1·048	1·029	1·009	·991	·972	·956	·939	·923	·908	·894
890	1·104	1·082	1·060	1·040	1·021	1·002	·983	·966	·950	·934	·918	·904
900	1·117	1·094	1·072	1·052	1·032	1·013	·994	·977	·960	·944	·928	·914
910	1·129	1·106	1·084	1·063	1·043	1·024	1·005	·988	·971	·954	·939	·324
920	1·141	1·118	1·095	1·074	1·054	1·035	1·016	·998	·981	·964	·949	·934
930	1·153	1·130	1·107	1·086	1·065	1·046	1·027	1·009	·992	·975	·959	·944
940	1·166	1·142	1·119	1·097	1·076	1·057	1·038	1·019	1·002	·985	·969	·954
950	1·180	1·154	1·131	1·109	1·088	1·069	1·049	1·030	1·012	·995	·979	·964
960	1·193	1·165	1·142	1·121	1·100	1·080	1·059	1·040	1·023	1·005	·989	·974
970	1·205	1·177	1·154	1·132	1·111	1·091	1·070	1·051	1·033	1·016	·999	·984
980	1·216	1·189	1·165	1·143	1·121	1·102	1·081	1·062	1·044	1·026	1·010	·994
990	1·227	1·201	1·177	1·154	1·133	1·113	1·092	1·073	1·054	1·036	1·020	1·004
1000	1·238	1·213	1·189	1·166	1·144	1·124	1·103	1·083	1·065	1·047	1·030	1·014
1010	1·250	1·225	1·200	1·177	1·155	1·135	1·113	1·093	1·075	1·057	1·040	1·024
1020	1·262	1·237	1·211	1·188	1·166	1·145	1·124	1·103	1·085	1·067	1·050	1·034
1030	1·274	1·249	1·223	1·200	1·177	1·156	1·135	1·114	1·095	1·077	1·060	1·044
1040	1·286	1·261	1·235	1·212	1·188	1·167	1·146	1·125	1·106	1·087	1·070	1·054
1050	1·299	1·273	1·247	1·223	1·200	1·178	1·157	1·136	1·117	1·098	1·080	1·064
1060	1·311	1·285	1·259	1·234	1·211	1·189	1·168	1·146	1·127	1·108	1·090	1·074
1070	1·323	1·297	1·271	1·245	1·222	1·200	1·179	1·156	1·137	1·118	1·100	1·084
1080	1·335	1·309	1·283	1·256	1·233	1·211	1·190	1·167	1·147	1·129	1·110	1·094
1090	1·347	1·321	1·294	1·268	1·244	1·222	1·200	1·178	1·158	1·139	1·120	1·103
1100	1·359	1·332	1·305	1·280	1·256	1·232	1·211	1·189	1·169	1·150	1·131	1·113
1110	1·371	1·344	1·317	1·292	1·267	1·243	1·221	1·200	1·179	1·160	1·141	1·123
1120	1·383	1·356	1·328	1·302	1·278	1·254	1·232	1·210	1·189	1·170	1·151	1·133
1130	1·395	1·367	1·340	1·313	1·289	1·265	1·243	1·221	1·200	1·180	1·161	1·143
1140	1·407	1·379	1·352	1·325	1·300	1·276	1·254	1·231	1·210	1·190	1·171	1·153
1150	1·419	1·390	1·363	1·336	1·312	1·287	1·265	1·242	1·221	1·201	1·182	1·163
1160	1·431	1·402	1·375	1·348	1·323	1·298	1·276	1·253	1·231	1·211	1·192	1·173
1170	1·443	1·414	1·387	1·360	1·334	1·309	1·287	1·263	1·242	1·221	1·202	1·183
1180	1·455	1·426	1·399	1·371	1·345	1·320	1·297	1·274	1·252	1·231	1·212	1·193
1190	1·467	1·437	1·410	1·383	1·356	1·331	1·307	1·284	1·263	1·242	1·222	1·202

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
1190	1·467	1·437	1·410	1·383	1·356	1·331	1·307	1·284	1·263	1·242	1·222	1·202
1200	1·480	1·449	1·421	1·394	1·367	1·342	1·318	1·295	1·273	1·252	1·232	1·212
1210	1·492	1·461	1·432	1·405	1·378	1·353	1·328	1·306	1·283	1·262	1·242	1·222
1220	1·504	1·473	1·443	1·416	1·389	1·364	1·339	1·316	1·293	1·272	1·252	1·232
1230	1·516	1·485	1·454	1·427	1·400	1·375	1·350	1·326	1·303	1·282	1·262	1·242
1240	1·528	1·496	1·466	1·438	1·411	1·386	1·361	1·337	1·313	1·292	1·272	1·252
1250	1·540	1·508	1·478	1·450	1·423	1·397	1·371	1·348	1·324	1·303	1·282	1·262
1260	1·552	1·520	1·490	1·461	1·434	1·408	1·382	1·359	1·335	1·314	1·292	1·272
1270	1·564	1·532	1·502	1·472	1·445	1·419	1·393	1·370	1·346	1·324	1·302	1·282
1280	1·576	1·544	1·513	1·483	1·456	1·430	1·404	1·381	1·356	1·334	1·312	1·292
1290	1·588	1·556	1·525	1·494	1·467	1·441	1·415	1·391	1·367	1·344	1·322	1·301
1300	1·600	1·567	1·536	1·506	1·478	1·451	1·425	1·401	1·377	1·354	1·332	1·310
1310	1·612	1·579	1·548	1·518	1·489	1·462	1·435	1·411	1·387	1·364	1·342	1·320
1320	1·624	1·591	1·560	1·529	1·500	1·473	1·446	1·421	1·397	1·374	1·352	1·330
1330	1·636	1·603	1·572	1·540	1·511	1·484	1·457	1·431	1·407	1·384	1·362	1·340
1340	1·648	1·615	1·583	1·551	1·522	1·495	1·468	1·442	1·417	1·394	1·372	1·350
1350	1·659	1·626	1·594	1·563	1·534	1·506	1·479	1·453	1·428	1·405	1·382	1·360
1360	1·671	1·637	1·605	1·574	1·545	1·516	1·490	1·464	1·439	1·416	1·392	1·369
1370	1·683	1·649	1·616	1·585	1·556	1·527	1·500	1·475	1·449	1·426	1·402	1·379
1380	1·695	1·661	1·628	1·596	1·567	1·538	1·510	1·485	1·460	1·436	1·412	1·389
1390	1·707	1·673	1·639	1·607	1·578	1·549	1·521	1·496	1·470	1·446	1·422	1·399
1400	1·719	1·684	1·651	1·619	1·589	1·560	1·531	1·506	1·480	1·456	1·432	1·409
1410	1·731	1·695	1·662	1·630	1·600	1·570	1·541	1·517	1·490	1·466	1·442	1·419
1420	1·743	1·707	1·673	1·641	1·611	1·581	1·552	1·528	1·500	1·476	1·452	1·429
1430	1·755	1·719	1·685	1·652	1·622	1·592	1·563	1·538	1·510	1·486	1·462	1·439
1440	1·767	1·730	1·697	1·664	1·633	1·603	1·574	1·548	1·520	1·496	1·472	1·449
1450	1·779	1·742	1·709	1·675	1·644	1·614	1·585	1·558	1·531	1·506	1·483	1·459
1460	1·791	1·753	1·720	1·686	1·655	1·624	1·595	1·568	1·542	1·516	1·492	1·469
1470	1·803	1·765	1·731	1·697	1·666	1·635	1·605	1·578	1·552	1·526	1·501	1·479
1480	1·815	1·776	1·742	1·708	1·677	1·646	1·616	1·588	1·562	1·536	1·511	1·489
1490	1·827	1·788	1·754	1·719	1·688	1·657	1·627	1·599	1·573	1·546	1·521	1·499
1500	1·838	1·800	1·766	1·731	1·699	1·668	1·638	1·610	1·583	1·556	1·531	1·508
1510	1·850	1·812	1·777	1·742	1·710	1·678	1·649	1·620	1·593	1·566	1·541	1·517
1520	1·862	1·824	1·788	1·753	1·721	1·689	1·660	1·630	1·603	1·576	1·551	1·527
1530	1·874	1·836	1·799	1·764	1·732	1·700	1·670	1·640	1·613	1·586	1·561	1·536
1540	1·886	1·848	1·811	1·775	1·743	1·711	1·681	1·651	1·623	1·596	1·571	1·546
1550	1·897	1·859	1·823	1·787	1·754	1·722	1·691	1·662	1·634	1·607	1·581	1·556
1560	1·909	1·871	1·835	1·798	1·765	1·733	1·701	1·672	1·644	1·617	1·591	1·566
1570	1·921	1·883	1·847	1·809	1·776	1·744	1·712	1·683	1·654	1·627	1·601	1·576
1580	1·933	1·895	1·859	1·820	1·787	1·755	1·722	1·693	1·664	1·637	1·611	1·586
1590	1·945	1·906	1·870	1·831	1·798	1·766	1·733	1·704	1·674	1·647	1·621	1·596
1600	1·956	1·917	1·881	1·842	1·808	1·776	1·744	1·714	1·685	1·657	1·631	1·605
1610	1·967	1·928	1·892	1·853	1·819	1·786	1·755	1·724	1·695	1·668	1·640	1·615
1620	1·979	1·939	1·903	1·864	1·830	1·797	1·765	1·735	1·705	1·678	1·650	1·625
1630	1·991	1·951	1·914	1·875	1·841	1·807	1·776	1·745	1·716	1·688	1·660	1·635
1640	2·003	1·963	1·925	1·886	1·852	1·818	1·786	1·756	1·726	1·698	1·670	1·645
1650	2·014	1·975	1·937	1·898	1·863	1·829	1·797	1·766	1·737	1·708	1·680	1·655
1660	2·026	1·986	1·949	1·909	1·874	1·839	1·807	1·776	1·747	1·718	1·690	1·664
1670	2·038	1·997	1·961	1·920	1·885	1·850	1·818	1·787	1·757	1·728	1·700	1·674
1680	2·050	2·008	1·972	1·931	1·896	1·861	1·829	1·797	1·767	1·738	1·710	1·684
1690	2·061	2·020	1·983	1·942	1·907	1·872	1·839	1·808	1·777	1·748	1·720	1·694
1700	2·073	2·031	1·994	1·954	1·917	1·883	1·850	1·818	1·787	1·758	1·730	1·704
1710	2·085	2·042	2·005	1·965	1·928	1·894	1·860	1·828	1·298	1·769	1·739	1·714
1720	2·097	2·054	2·016	1·976	1·939	1·905	1·871	1·839	1·808	1·779	1·749	1·723
1730	2·109	2·066	2·027	1·987	1·950	1·916	1·881	1·849	1·818	1·789	1·759	1·733
1740	2·121	2·078	2·038	1·998	1·961	1·927	1·892	1·860	1·829	1·799	1·769	1·742
1750	2·132	2·090	2·050	2·010	1·972	1·937	1·903	1·870	1·839	1·809	1·779	1·752
1760	2·143	2·101	2·061	2·021	1·983	1·948	1·913	1·880	1·849	1·819	1·789	1·762
1770	2·155	2·113	2·072	2·032	1·994	1·959	1·924	1·891	1·859	1·829	1·799	1·772
1780	2·167	2·125	2·083	2·043	2·005	1·969	1·935	1·901	1·869	1·839	1·809	1·781

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
1780	2·167	2·125	2·083	2·043	2·005	1·969	1·935	1·901	1·869	1·839	1·809	1·781
1790	2·179	2·136	2·094	2·054	2·016	1·980	1·945	1·912	1·879	1·849	1·819	1·791
1800	2·191	2·147	2·106	2·066	2·027	1·991	1·956	1·922	1·889	1·859	1·829	1·801
1810	2·203	2·158	2·117	2·077	2·038	2·002	1·966	1·932	1·899	1·869	1·839	1·810
1820	2·215	2·170	2·128	2·088	2·049	2·013	1·977	1·942	1·909	1·879	1·848	1·820
1830	2·227	2·182	2·139	2·099	2·059	2·023	1·987	1·953	1·919	1·889	1·858	1·830
1840	2·238	2·194	2·150	2·110	2·070	2·034	1·998	1·963	1·929	1·899	1·868	1·840
1850	2·250	2·205	2·162	2·120	2·081	2·044	2·008	1·973	1·939	1·909	1·878	1·849
1860	2·262	2·217	2·173	2·131	2·092	2·055	2·019	1·984	1·950	1·919	1·888	1·859
1870	2·274	2·229	2·184	2·142	2·103	2·065	2·029	1·994	1·960	1·929	1·898	1·869
1880	2·286	2·241	2·195	2·153	2·114	2·076	2·040	2·004	1·970	1·939	1·907	1·878
1890	2·298	2·252	2·206	2·165	2·125	2·087	2·050	2·015	1·980	1·945	1·917	1·888
1900	2·309	2·263	2·218	2·176	2·136	2·098	2·061	2·025	1·990	1·959	1·927	1·897
1910	2·321	2·275	2·229	2·187	2·147	2·108	2·071	2·035	2·000	1·969	1·937	1·907
1920	2·333	2·286	2·240	2·196	2·158	2·119	2·082	1·046	2·010	1·979	1·947	1·917
1930	2·344	2·297	2·251	2·210	2·168	2·130	2·092	2·056	2·021	1·989	1·956	1·926
1940	2·356	2·309	2·263	2·221	2·179	2·140	2·103	2·067	2·031	1·999	1·966	1·936
1950	2·367	2·320	2·275	2·232	2·190	2·151	2·113	2·077	2·041	2·009	1·976	1·945
1960	2·379	2·332	2·286	2·243	2·200	2·161	2·123	2·087	2·051	2·019	1·986	1·955
1970	2·391	2·344	2·297	2·254	2·211	2·172	2·134	2·097	2·061	2·029	1·995	1·965
1980	2·403	2·356	2·308	2·265	2·222	2·183	2·144	2·108	2·072	2·039	2·005	1·975
1990	2·415	2·367	2·319	2·276	2·233	2·193	2·155	2·118	2·082	2·049	2·015	1·984
2000	2·426	2·378	2·331	2·287	2·244	2·204	2·165	2·128	2·092	2·058	2·024	1·994
2010	2·438	2·390	2·343	2·298	2·255	2·215	2·176	2·138	2·102	2·068	2·034	2·003
2020	2·450	2·402	2·354	2·309	2·266	2·226	2·186	2·148	2·112	2·078	2·044	2·013
2030	2·462	2·413	2·365	2·320	2·277	2·236	2·196	2·158	2·122	2·088	2·054	2·022
2040	2·473	2·424	2·376	2·331	2·388	2·247	2·206	2·169	2·132	2·098	2·063	2·032
2050	2·484	2·435	2·387	2·342	2·299	2·257	2·216	2·179	2·142	2·108	2·073	2·041
2060	2·496	2·447	2·398	2·353	2·310	2·268	2·227	2·189	2·152	2·118	2·083	2·051
2070	2·508	2·459	2·409	2·364	2·321	2·278	2·237	2·199	2·162	2·127	2·093	2·060
2080	2·519	2·470	2·420	2·375	2·331	2·289	2·247	2·210	2·172	2·137	2·102	2·070
2090	2·530	2·481	2·431	2·386	2·342	2·299	2·258	2·220	2·182	2·147	2·112	2·079
2100	2·541	2·492	2·442	2·396	2·352	2·310	2·268	2·230	2·192	2·157	2·121	2·089
2110	2·553	2·504	2·454	2·407	2·363	2·320	2·278	2·240	2·202	2·167	2·131	2·098
2120	2·565	2·515	2·465	2·418	2·373	2·330	2·289	2·250	2·212	2·177	2·141	2·108
2130	2·576	2·526	2·476	2·429	2·384	2·341	2·299	2·261	2·222	2·187	2·151	2·117
2140	2·588	2·537	2·487	2·440	2·394	2·351	2·310	2·271	2·232	2·197	2·160	2·127
2150	2·599	2·548	2·498	2·451	2·405	2·362	2·320	2·281	2·242	2·207	2·170	2·136
2160	2·611	2·560	2·509	2·462	2·416	2·372	2·331	2·291	2·252	2·217	2·180	2·146
2170	2·623	2·571	2·520	2·473	2·427	2·383	2·341	2·301	2·262	2·227	2·190	2·155
2180	2·634	2·583	2·531	2·484	2·437	2·393	2·351	2·311	2·272	2·236	2·200	2·165
2190	2·646	2·595	2·542	2·495	2·448	2·404	2·362	2·322	2·283	2·246	2·210	2·175
2200	2·657	2·606	2·553	2·506	2·459	2·414	2·372	2·332	2·293	2·256	2·219	2·184
2210	2·669	2·617	2·564	2·517	2·470	2·425	2·382	2·342	2·303	2·266	2·229	2·194
2220	2·681	2·628	2·575	2·528	2·481	2·435	2·393	2·352	2·313	2·276	2·239	2·204
2230	2·692	2·639	2·587	2·539	2·491	2·446	2·403	2·363	2·323	2·286	2·249	2·213
2240	2·703	2·650	2·598	2·550	2·502	2·456	2·413	2·373	2·333	2·296	2·258	2·223
2250	2·715	2·661	2·609	2·560	2·512	2·467	2·424	2·383	2·343	2·306	2·268	2·232
2260	2·726	2·672	2·620	2·571	2·523	2·477	2·434	2·393	2·353	2·315	2·278	2·242
2270	2·737	2·683	2·631	2·582	2·534	2·488	2·444	2·403	2·363	2·325	2·287	2·252
2280	2·748	2·694	2·642	2·592	2·544	2·498	2·455	2·413	2·373	2·335	2·297	2·261
2290	2·760	2·705	2·653	2·603	2·555	2·509	2·465	2·424	2·383	2·345	2·307	2·271
2300	2·771	2·715	2·663	2·614	2·566	2·520	2·476	2·434	2·393	2·355	2·316	2·280
2310	2·783	2·726	2·674	2·625	2·576	2·530	2·486	2·444	2·403	2·364	2·326	2·290
2320	2·795	2·738	2·685	2·636	2·587	2·541	2·496	2·454	2·413	2·374	2·335	2·300
2330	2·807	2·750	2·697	2·646	2·598	2·551	2·507	2·464	2·423	2·384	2·345	2·309
2340	2·819	2·761	2·708	2·657	2·608	2·562	2·517	2·474	2·433	2·394	2·355	2·319
2350	2·831	2·773	2·719	2·668	2·619	2·572	2·527	2·484	2·443	2·404	2·364	2·328
2360	2·843	2·784	2·729	2·678	2·630	2·583	2·538	2·494	2·453	2·413	2·374	2·338
2370	2·855	2·796	2·740	2·689	2·640	2·593	2·548	2·504	2·463	2·423	2·384	2·347

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
2370	2·855	2·796	2·740	2·689	2·640	2·593	2·548	2·504	2·463	2·423	2·384	2·347
2380	2·866	2·807	2·751	2·699	2·651	2·604	2·558	2·514	2·473	2·433	2·393	2·356
2390	2·877	2·818	2·762	2·710	2·662	2·614	2·569	2·524	2·483	2·443	2·403	2·366
2400	2·888	2·829	2·773	2·720	2·673	2·625	2·579	2·534	2·493	2·453	2·413	2·375
2410	2·899	2·840	2·784	2·731	2·683	2·635	2·589	2·544	2·503	2·462	2·423	2·385
2420	2·910	2·851	2·795	2·742	2·694	2·645	2·599	2·554	2·513	2·472	2·432	2·395
2430	2·922	2·862	2·807	2·754	2·704	2·656	2·609	2·564	2·523	2·482	2·442	2·404
2440	2·933	2·873	2·818	2·766	2·715	2·666	2·619	2·574	2·532	2·492	2·452	2·414
2450	2·944	2·884	2·829	2·777	2·725	2·676	2·629	2·584	2·542	2·501	2·461	2·423
2460	2·956	2·896	2·840	2·788	2·736	2·687	2·639	2·595	2·552	2·511	2·471	2·433
2470	2·967	2·907	2·851	2·799	2·746	2·697	2·649	2·605	2·562	2·521	2·481	2·442
2480	2·978	2·918	2·862	2·810	2·757	2·707	2·660	2·615	2·572	2·531	2·491	2·452
2490	2·989	2·929	2·873	2·821	2·767	2·718	2·670	2·625	2·582	2·541	2·500	2·461
2500	3·001	2·940	2·884	2·831	2·778	2·728	2·680	2·635	2·591	2·550	2·510	2·471
2510	3·013	2·952	2·896	2·842	2·788	2·739	2·690	2·645	2·601	2·560	2·520	2·480
2520	3·024	2·963	2·907	2·853	2·799	2·749	2·700	2·655	2·611	2·570	2·529	2·490
2530	3·035	2·974	2·918	2·863	2·809	2·760	2·711	2·665	2·621	2·579	2·539	2·499
2540	3·047	2·985	2·929	2·874	2·820	2·770	2·721	2·675	2·631	2·589	2·549	2·508
2550	3·058	2·996	2·940	2·885	2·830	2·780	2·731	2·685	2·640	2·599	2·558	2·518
2560	3·070	3·007	2·950	2·895	2·841	2·790	2·741	2·695	2·650	2·609	2·568	2·527
2570	3·081	3·018	2·961	2·906	2·851	2·801	2·751	2·705	2·660	2·618	2·577	2·537
2580	3·093	3·030	2·972	2·917	2·862	2·811	2·762	2·715	2·670	2·628	2·587	2·546
2590	3·104	3·041	2·982	2·928	2·872	2·821	2·772	2·725	2·680	2·638	2·596	2·556
2600	3·115	3·052	2·993	2·938	2·883	2·831	2·782	2·735	2·689	2·647	2·606	2·565
2610	3·127	3·063	3·004	2·949	2·893	2·842	2·792	2·745	2·699	2·657	2·615	2·575
2620	3·138	3·075	3·014	2·959	2·904	2·852	2·802	2·755	2·709	2·666	2·625	2·584
2630	3·150	3·086	3·025	2·970	2·915	2·862	2·813	2·765	2·719	2·676	2·634	2·593
2640	3·161	3·097	3·036	2·980	2·925	2·872	2·823	2·775	2·729	2·686	2·644	2·603
2650	3·172	3·108	3·047	2·991	2·936	2·883	2·833	2·785	2·739	2·695	2·653	2·612
2660	3·183	3·119	3·058	3·002	2·946	2·893	2·843	2·795	2·749	2·705	2·663	2·622
2670	3·194	3·130	3·069	3·013	2·957	2·904	2·853	2·805	2·759	2·715	2·672	2·631
2680	3·206	3·142	3·080	3·023	2·967	2·914	2·864	2·815	2·769	2·724	2·681	2·640
2690	3·217	3·153	3·091	3·034	2·978	2·924	2·874	2·825	2·779	2·734	2·691	2·650
2700	3·228	3·164	3·102	3·045	2·988	2·935	2·884	2·835	2·788	2·743	2·700	2·659
2710	3·240	3·175	3·113	3·055	2·999	2·945	2·894	2·845	2·798	2·753	2·710	2·669
2720	3·251	3·187	3·123	3·066	3·010	2·956	2·904	2·855	2·803	2·763	2·719	2·678
2730	3·263	3·198	3·134	3·077	3·020	2·966	2·915	2·865	2·818	2·772	2·729	2·688
2740	3·274	3·209	3·145	3·087	3·031	2·977	2·925	2·875	2·828	2·782	2·738	2·697
2750	3·285	3·220	3·156	3·098	3·041	2·987	2·935	2·885	2·838	2·792	2·748	2·706
2760	3·297	3·231	3·167	3·109	3·052	2·997	2·945	2·895	2·848	2·801	2·758	2·716
2770	3·308	3·242	3·179	3·119	3·062	3·008	2·955	2·905	2·858	2·811	2·767	2·725
2780	3·319	3·253	3·190	3·130	3·073	3·018	2·966	2·915	2·868	2·821	2·777	2·734
2790	3·330	3·264	3·201	3·141	3·083	3·028	2·976	2·925	2·878	2·830	2·786	2·744
2800	3·341	3·275	3·212	3·152	3·094	3·039	2·986	2·935	2·888	2·840	2·796	2·753
2810	3·353	3·286	3·223	3·162	3·104	3·049	2·996	2·945	2·897	2·850	2·805	2·762
2820	3·364	3·297	3·233	3·173	3·115	3·059	3·006	2·955	2·907	2·860	2·815	2·771
2830	3·375	3·308	3·244	3·183	3·125	3·069	3·017	2·965	2·917	2·869	2·824	2·781
2840	3·386	3·319	3·255	3·194	3·136	3·080	3·027	2·975	2·927	2·879	2·834	2·790
2850	3·397	3·330	3·266	3·205	3·146	3·090	3·037	2·985	2·936	2·889	2·843	2·799
2860	3·409	3·341	3·277	3·215	3·157	3·100	3·047	2·995	2·946	2·899	2·853	2·808
2870	3·420	3·352	3·287	3·226	3·167	3·110	3·057	3·005	2·956	2·908	2·862	2·817
2880	3·431	3·363	3·298	3·237	3·178	3·121	3·068	3·015	2·966	2·918	2·872	2·827
2890	3·442	3·374	3·309	3·248	3·188	3·131	3·078	3·025	2·975	2·927	2·882	2·836
2900	3·453	3·385	3·320	3·259	3·199	3·141	3·088	3·035	2·985	2·937	2·891	2·845
2910	3·465	3·396	3·331	3·269	3·209	3·151	3·098	3·045	2·994	2·947	2·901	2·855
2920	3·476	3·407	3·342	3·280	3·220	3·162	3·108	3·054	3·004	2·956	2·910	2·864
2930	3·487	3·418	3·352	3·290	3·230	3·172	3·119	3·064	3·014	2·966	2·920	2·874
2940	3·498	3·429	3·363	3·300	3·241	3·182	3·129	3·074	3·023	2·976	2·929	2·883
2950	3·509	3·440	3·374	3·310	3·251	3·193	3·139	3·084	3·033	2·985	2·939	2·892
2960	3·521	3·451	3·384	3·321	3·262	3·203	3·149	3·094	3·043	2·995	2·948	2·902

Height in Feet.	Temperature. Mean of Upper and Lower Stations.											
	−20°	−10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.
2960	3·521	3·451	3·384	3·321	3·262	3·203	3·149	3·094	3·043	2·995	2·948	2·902
2970	3·532	3·462	3·394	3·332	3·272	3·214	3·159	3·104	3·052	3·004	2·958	2·911
2980	3·543	3·473	3·405	3·342	3·283	3·224	3·170	3·114	3·062	3·014	2·967	2·921
2990	3·554	3·484	3·415	3·353	3·293	3·235	3·180	3·124	3·072	3·024	2·977	2·931
3000	3·565	3·495	3·425	3·364	3·304	3·245	3·190	3·134	3·081	3·033	2·986	2·940
3100	3·674	3·603	3·532	3·468	3·406	3·346	3·289	3·232	3·178	3·128	3·080	3·033
3200	3·785	3·712	3·638	3·573	3·509	3·447	3·389	3·330	3·275	3·224	3·174	3·124
3300	3·895	3·820	3·745	3·678	3·612	3·549	3·488	3·428	3·372	3·319	3·268	3·216
3400	4·005	3·927	3·851	3·783	3·715	3·650	3·587	3·526	3·470	3·415	3·361	3·308
3500	4·115	4·035	3·958	3·887	3·818	3·751	3·686	3·624	3·567	3·509	3·454	3·399
3600	4·222	4·138	4·063	3·991	3·918	3·851	3·784	3·721	3·660	3·603	3·546	3·480
3700	4·330	4·246	4·167	4·092	4·018	3·950	3·882	3·816	3·756	3·696	3·638	3·581
3800	4·437	4·353	4·272	4·195	4·119	4·049	3·979	3·913	3·850	3·790	3·730	3·670
3900	4·545	4·458	4·376	4·297	4·220	4·147	4·077	4·009	3·945	3·883	3·822	3·761
4000	4·652	4·564	4·480	4·400	4·321	4·246	4·174	4·105	4·039	3·976	3·915	3·852
4100	4·757	4·668	4·582	4·500	4·420	4·342	4·270	4·199	4·131	4·067	4·003	3·942
4200	4·861	4·773	4·683	4·600	4·518	4·441	4·367	4·293	4·224	4·159	4·093	4·028
4300	4·970	4·877	4·785	4·700	4·617	4·538	4·462	4·387	4·317	4·250	4·183	4·119
4400	5·077	4·980	4·887	4·800	4·715	4·633	4·557	4·481	4·409	4·341	4·273	4.208
4500	5·182	5·083	4·990	4·899	4·813	4·730	4·652	4·575	4·502	4·437	4·363	4·296
4600	5·285	5·185	5·089	4·998	4·910	4·827	4·745	4·668	4·593	4·521	4·452	4·384
4700	5·388	5·288	5·189	5·097	5·007	4·922	4·839	4·761	4·685	4·611	4·541	4·473
4800	5·492	5·389	5·289	5·195	5·104	5·017	4·932	4·853	4·776	4·700	4·630	4·560
4900	5·595	5·491	5·389	5·294	5·201	5·113	5·027	4·944	4·867	4·790	4·718	4·648
5000	5·698	5·592	5·490	5·392	5·297	5·207	5·121	5·037	4·957	4·881	4·808	4·737
5100	5·800	5·692	5·588	5·489	5·393	5·301	5·214	5·128	5·048	4·969	4·895	4·822
5200	5·900	5·791	5·686	5·586	5·488	5·395	5·306	5·220	5·137	5·058	4·982	4·908
5300	6·001	5·891	5·784	5·682	5·583	5·488	5·399	5·311	5·227	5·147	5·069	4·994
5400	6·102	5·990	5·882	5·778	5·679	5·584	5·491	5·402	5·317	5·235	5·156	5·080
5500	6·203	6·090	5·981	5·875	5·773	5·676	5·583	5·493	5·406	5·324	5·243	5·166
5600	6·302	6·187	6·076	5·970	5·866	5·768	5·673	5·582	5·494	5·410	5·329	5·251
5700	6·401	6·284	6·172	6·065	5·959	5·860	5·763	5·671	5·582	5·497	5·415	5·336
5800	6·501	6·381	6·268	6·159	6·052	5·951	5·853	5·760	5·669	5·584	5·501	5·420
5900	6·601	6·479	6·364	6·253	6·145	6·043	5·943	5·849	5·756	5·671	5·586	5·504
6000	6·700	6·577	6·460	6·347	6·239	6·134	6·033	5·937	5·844	5·757	5·671	5·588
6100	6·797	6·673	6·555	6·440	6·330	6·225	6·123	6·025	5·931	5·843	5·756	5·672
6200	6·894	6·769	6·649	6·533	6·421	6·316	6·212	6·113	6·018	5·929	5·840	5·755
6300	6·990	6·865	6·743	6·626	6·513	6·406	6·301	6·201	6·105	6·014	5·924	5·838
6400	7·087	6·961	6·837	6·719	6·605	6·496	6·390	6·289	6·192	6·099	6·008	5·921
6500	7·185	7·056	6·931	6·811	6·696	6·586	6·479	6·377	6·279	6·181	6·092	6·004
6600	7·281	7·148	7·024	6·902	6·786	6·675	6·567	6·464	6·364	6·268	6·175	6·086
6700	7·377	7·240	7·117	6·993	6·876	6·764	6·655	6·550	6·449	6·352	6·258	6·168
6800	7·472	7·332	7·209	7·084	6·966	6·852	6·742	6·636	6·534	6·435	6·341	6·250
6900	7·567	7·424	7·301	7·175	7·055	6·940	6·829	6·722	6·619	6·518	6·423	6·331
7000	7·662	7·525	7·393	7·266	7·145	7·028	6·916	6·808	6·703	6·602	6·505	6·412
7100	7·756	7·617	7·484	8·356	7·233	7·115	7·002	6·893	6·787	6·685	6·587	6·493
7200	7·849	7·709	7·574	7·445	7·321	7·202	7·088	6·977	6·870	6·768	6·669	6·574
7300	7·942	7·801	7·664	7·534	7·409	7·289	7·174	7·061	6·953	6·850	6·751	6·654
7400	8·035	7·892	7·754	7·623	7·497	7·376	7·259	7·145	7·036	6·932	6·832	6·734
7500	8·128	7·983	7·844	7·712	7·584	7·462	7·344	7·229	7·119	7·014	6·913	6·814
7600	8·219	8·073	7·933	7·800	7·671	7·547	7·428	7·312	7·201	7·095	6·993	6·893
7700	8·310	8·163	8·022	7·888	7·758	7·632	7·512	7·395	7·283	7·176	7·073	6·972
7800	8·401	8·253	8·111	7·975	7·844	7·717	7·596	7·478	7·365	7·257	7·153	7·051
7900	8·492	8·343	8·199	8·062	7·930	7·803	7·680	7·561	7·447	7·338	7·233	7·130
8000	8·582	8·432	8·287	8·149	8·016	7·887	7·763	7·644	7·529	7·418	7·312	7·208

TABLE VI.

SHOWING THE MEAN MONTHLY AND ANNUAL HEIGHT OF THE BAROMETER, REDUCED TO 32°, IN ENGLISH INCHES, AT DIFFERENT PLACES OVER THE GLOBE.

Note.—Under column of "Hours of Observation" the Hours of the A.M. Observations are placed before the Colon [:], the P.M. after it. In the same column M.P. signifies that the Means have been reduced to the approximate Mean Pressures. A Minus before Latitudes signifies Latitude South, and before Longitudes it signifies Longitude West. The Observations are also reduced to sea-level at those places which are printed in *Italics*. In the last column are entered the Corrections for Errors which have been made in constructing the Table.

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Malin Head, .	Ireland	15	1870–84	8 :	55 23	−7 22	230
Greencastle, . .	do.	15	do.	8 :	55 12	−7 2	70
Londonderry, .	do.	15	do.	9 : 9	55 0	−7 19	93
Mullaghmore, .	do.	15	do.	8 :	54 28	−8 28	40
Markree, . .	do.	15	do.	9 : 9	54 11	−8 27	131
Lissan, . .	do.	15	do.	do.	54 41	−6 45	305
Armagh, . .	do.	15	do.	24 daily	54 21	−6 39	207
Belfast, . .	do.	15	do.	M.P.	54 36	−5 56	66
Aghalee, . .	do.	15	do.	9 : 9	54 31	−6 16	130
Donaghadee, . .	do.	15	do.	8 :	54 38	−5 34	50
Milltown, . .	do.	15	do.	M.P.	54 23	−6 16	200
Dublin, . .	do.	15	do.	$9\frac{1}{2}$: $3\frac{1}{2}$	53 22	−6 21	158
Kingstown, . .	do.	15	do.	8 :	53 17	−6 8	50
Curragh Camp, .	do.	15	do.	9 : 3	53 9	−6 49	450
Galway, . .	do.	15	do.	$11\frac{1}{2}$:	53 15	−9 3	32
Belmullet, . .	do.	15	do.	8 :	54 12	−10 0	40
Parsonstown, .	do.	15	do.	9 : 9	53 6	−7 55	182
Roche's Point, .	do.	15	do.	8 :	51 47	−8 19	32
Killarney, . .	do.	15	do.	9 : 9	52 4	−9 30	90
Valentia, . .	do.	15	do.	hourly	51 55	−10 18	23
North Unst, . .	Scotland	15	do.	9 : 9	60 51	−0 53	230
Bressay, . .	do.	15	do.	do.	60 6	−1 8	105
Dunrossness, .	do.	15	do.	8 :	59 55	−1 20	126
Start Point, . .	do.	15	do.	9 : 9	59 17	−2 22	83
Sandwick, . .	do.	15	do.	do.	59 2	−3 18	94
Wick, . . .	do.	15	do.	8 :	58 27	−3 5	27
Holborn Head, .	do.	15	do.	9 : 9	58 37	−3 32	75
Dunrobin, . .	do.	15	do.	do.	57 59	−3 56	16
Lairg, . . .	do.	15	do.	do.	58 1	−4 22	458
Cape Wrath, .	do.	15	do.	do.	58 38	−5 0	400
Butt of Lewis, .	do.	15	do.	do.	58 31	−6 16	170
Stornoway, . .	do.	15	do.	do.	58 13	−6 23	70
Monach, . .	do.	15	do.	do.	57 32	−7 14	150
Barra Head, . .	do.	15	do.	do.	56 47	−7 39	683
Skerryvore, . .	do.	15	do.	do.	56 19	−7 7	150
Glencarron, . .	do.	15	do.	do.	57 30	−5 14	504
Culloden, . .	do.	15	do.	do.	57 29	−4 8	104
Fort William, .	do.	4	1884–87	do.	56 49	−5 7	30
Ben Nevis Observ.,	do.	4	do.	do.	56 49	−5 7	4406
Gordon Castle, .	do.	15	1870–84	do.	57 37	−3 5	104
New Pitsligo, .	do.	15	do.	do.	57 36	−2 12	495
Braemar, . .	do.	15	do.	do.	57 0	−3 24	1114
Aberdeen, . .	do.	15	do.	do.	57 10	−2 6	84
Dundee, . .	do.	15	do.	do.	56 28	−2 56	164
Dalnaspidal, .	do.	15	do.	do.	56 50	−4 13	1414
Ochtertyre, . .	do.	15	do.	do.	56 23	−3 53	333
Dollar, . . .	do.	15	do.	do.	56 10	−3 4	178
Bell Rock, . .	do.	15	do.	do.	56 26	−2 23	93
Ardnamurchan, .	do.	15	do.	do.	56 44	−6 13	180
Airds, . . .	do.	15	do.	do.	56 33	−5 25	15

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·779	29·782	29·858	29·840	29·948	29·900	29·840	29·852	29·850	29·788	29·774	29·796	29·834	...
29·830	29·825	29·882	29·871	29·969	29·910	29·864	29·872	29·868	29·817	29·795	29·816	29·861	...
29·855	29·828	29·895	29·870	29·967	29·913	29·867	29·873	29·868	29·823	29·797	29·845	29·867	−·015
29·812	29·794	29·876	29·852	29·950	29·910	29·866	29·861	29·863	29·810	29·790	29·822	29·851	...
29·856	29·822	29·900	29·870	29·973	29·920	29·874	29·880	29·889	29·837	29·820	29·849	29·875	...
29·518	29·504	29·574	29·552	29·646	29·585	29·541	29·563	29·571	29·504	29·484	29·519	23·547	...
29·643	29·623	29·688	29·658	29·760	29·712	29·666	29·678	29·687	29·622	29·600	29·633	29·665	...
29·867	29·853	29·915	29·890	29·986	29·932	29·885	29·896	29·910	29·846	29·826	29·852	29·888	...
29·860	29·843	29·903	29·885	29·992	29·939	29·887	29·898	29·897	29·842	29·819	29·850	29·885	−·025
29·875	29·849	29·903	29·882	29·985	29·932	29·877	29·885	29·889	29·834	29·816	29·830	29·879	...
29·660	29·642	29·685	29·672	29·762	29·713	29·666	29·682	29·678	29·624	29·610	29·637	29·669	+·060
29·911	29·883	29·940	29·896	30·018	29·958	29·926	29·920	29·925	29·875	29·859	29·888	29·926	+·015
29·918	29·885	29·947	29·892	30·012	29·956	29·936	29·922	29·928	29·864	29·858	29·892	29·918	...
29·907	29·864	29·925	29·876	29·996	29·947	29·914	29·908	29·917	29·860	29·850	29·880	29·904	...
29·822	29·797	29·882	29·822	29·945	29·898	29·869	29·866	29·873	29·814	29·805	29·830	29·852	+·020
29·802	29·770	29·858	29·836	29·963	29·916	29·867	29·861	29·868	29·826	29·804	29·836	29·850	...
29·906	29·868	29·943	29·881	29·993	29·945	29·917	29·914	29·921	29·864	29·852	29·895	29·907	...
29·901	29·873	29·925	29·864	29·994	29·957	29·929	29·929	29·930	29·864	29·858	29·896	29·910	...
29·894	29·870	29·940	29·877	30·002	29·970	29·931	29·926	29·937	29·872	29·877	29·900	29·916	...
29·851	29·819	29·910	29·832	29·968	29·934	29·918	29·888	29·930	29·833	29·835	29·850	29·880	...
29·432	29·490	29·500	29·606	29·644	29·619	29·543	29·558	29·536	29·454	29·450	29·413	29·520	...
29·591	29·646	29·656	29·747	29·778	29·756	29·679	29·696	29·675	29·600	29·589	29·577	29·665	...
29·703	29·751	29·765	29·857	29·892	29·860	29·792	29·806	29·784	29·700	29·698	29·690	29·772	...
29·633	29·676	29·703	29·782	29·828	29·793	29·722	29·735	29·715	29·638	29·620	29·617	29·705	...
29·609	29·654	29·680	29·759	29·812	29·774	29·700	29·718	29·708	29·627	29·604	29·598	29·687	...
29·725	29·769	29·802	29·865	29·919	29·876	29·802	29·820	29·808	29·739	29·717	29·716	29·797	...
29·637	29·680	29·720	29·782	29·838	29·796	29·726	29·738	29·734	29·666	29·637	29·641	29·716	...
29·749	29·775	29·808	29·863	29·918	29·873	29·810	29·833	29·815	29·760	29·738	29·736	29·806	...
29·222	29·270	29·313	29·362	29·428	29·390	29·326	29·348	29·329	29·262	29·243	29·240	29·311	...
29·270	29·310	29·352	29·415	29·486	29·446	29·381	29·390	29·361	29·310	29·282	29·264	29·356	...
29·506	29·554	29·607	29·665	29·732	29·688	29·625	29·635	29·626	29·542	29·523	29·517	29·602	...
29·636	29·672	29·730	29·786	29·858	29·806	29·737	29·755	29·748	29·664	29·646	29·642	29·722	...
29·561	29·590	29·663	29·700	29·784	29·730	29·672	29·685	29·676	29·591	29·575	29·573	29·650	...
29·016	29·035	29·102	29·125	29·211	29·161	29·122	29·127	29·110	29·047	29·021	29·025	29·090	...
29·608	29·625	29·686	29·697	29·791	29·742	29·690	29·690	29·683	29·620	29·594	29·609	29·670	...
29·183	29·227	29·274	29·323	29·397	29·367	29·306	29·320	29·302	29·237	29·210	29·225	29·281	...
29·656	29·710	29·725	29·758	29·832	29·780	29·715	29·732	29·728	29·658	29·624	29·641	29·713	...
29·704	29·831	29·917	29·869	29·870	30·030	29·912	29·889	29·842	29·865	29·827	29·728	29·857	...
24·104	24·219	24·287	24·278	24·313	24·511	24·429	24·428	24·336	24·299	24·237	24·118	24·296	...
29·655	29·682	29·718	29·760	29·828	29·774	29·720	29·726	29·726	29·669	29·632	29·654	29·713	...
29·231	29·253	29·277	29·328	29·390	29·353	29·286	29·306	29·293	29·232	29·199	29·198	29·278	...
28·574	28·576	28·614	28·664	28·726	28·694	28·643	28·654	28·646	28·570	28·532	28·546	28·620	...
29·710	29·724	29·754	29·796	29·854	29·808	29·744	29·756	29·758	29·693	29·664	29·676	29·745	...
29·636	29·646	29·680	29·702	29·771	29·723	29·658	29·672	29·672	29·621	29·590	29·606	29·667	...
28·250	28·264	28·311	28·346	28·416	28·387	28·332	28·347	28·340	28·266	28·223	28·225	28·309	...
29·470	29·460	29·491	29·515	29·591	29·540	29·480	29·495	29·503	29·438	29·404	29·420	29·484	...
29·641	29·633	29·682	29·696	29·774	29·726	29·660	29·682	29·688	29·628	29·604	29·608	29·667	...
29·732	29·727	29·754	29·780	29·849	29·803	29·739	29·751	29·753	29·700	29·666	29·690	29·746	...
29·574	29·587	29·647	29·665	29·747	29·705	29·650	29·662	29·654	29·581	29·562	29·574	29·634	...
29·790	29·792	29·833	29·855	29·922	29·868	29·824	29·843	29·833	29·780	29·760	29·771	29·821	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Callton Mor, .	Scotland	15	1870–84	9 : 9	56 8	−5 30	135
Mull of Kintyre, .	do.	15	do.	do.	55 19	−5 48	297
Eallabus, . .	do.	15	do.	do.	55 45	−6 18	71
Ardrossan, . .	do.	15	do.	8 :	55 38	−4 49	16
Corsewall, . .	do.	15	do.	9 : 9	55 0	−5 9	112
Glasgow, . .	do.	15	do.	hourly	55 53	−4 18	184
Ridge Park, . .	do.	15	do.	9 : 9	55 41	−3 37	630
Edinburgh, . .	do.	15	do.	do.	55 56	−3 11	162
Smeaton, . .	do.	15	do.	do.	56 0	−2 39	100
Marchmont, . .	do.	15	do.	do.	55 44	−2 25	500
Wolfelee, . .	do.	15	do.	do.	55 22	−2 39	601
Drumlanrig, . .	do.	15	do.	do.	55 16	−3 48	191
Cargen, . .	do.	15	do.	do.	55 2	−3 37	85
Mull of Galloway,	do.	15	do.	do.	54 38	−4 15	325
Carlisle, . .	England	15	do.	M.P.	54 53	−2 55	114
Barrow-in-Furness,	do.	15	do.	8 :	54 7	−3 11	60
Shields, . .	do.	15	do.	do.	55 0	−1 27	124
York, . . .	do.	15	do.	do.	53 58	−1 5	50
Spurnhead, . .	do.	15	do.	do.	53 34	0 7	28
Stonyhurst, . .	do.	15	do.	hourly	53 51	−2 28	361
Bidstone Observ.,	do.	15	do.	M.P.	53 23	−3 7	197
Cheadle, . .	do.	15	do.	9 : 9	52 28	−1 57	646
Shrewsbury, . .	do.	15	do.	do.	52 45	−2 57	266
Llandudno, . .	do.	15	do.	do.	53 21	−3 50	100
Holyhead, . .	do.	15	do.	8 :	53 18	−4 39	44
Lampeter, . .	do.	15	do.	M.P.	52 7	−4 5	420
Churchstoke, .	do.	15	do.	9 : 9	52 31	−3 5	548
Pembroke, . .	do.	15	do.	8 :	51 41	−5 30	150
Carmarthen, . .	do.	15	do.	9 : 9	51 52	−4 18	188
Mansfield, . .	do.	15	do.	do.	53 8	−1 12	349
Oxford, . .	do.	15	do.	M.P.	51 46	−1 16	212
Leicester, . .	do.	15	do.	9 : 9	52 39	−1 8	237
Hillington, . .	do.	15	do.	do.	52 48	0 33	88
Holkham, . .	do.	15	do.	M.P.	52 57	0 46	39
Somerleyton, .	do.	15	do.	9 : 9	52 32	1 37	50
Royston, . .	do.	15	do.	M.P.	52 2	−0 1	269
Greenwich, . .	do.	15	do.	do.	51 29	0 0	159
Kew, . . .	do.	15	do.	hourly	51 28	−0 19	34
Ramsgate, . .	do.	15	do.	9 : 9	51 20	1 25	105
Dover, . . .	do.	15	do.	8 :	51 7	1 18	46
Brighton, . .	do.	15	do.	M.P.	50 49	−0 8	206
Osborne, . .	do.	15	do.	do.	50 45	−1 16	172
Truro, . . .	do.	15	do.	do.	50 17	−5 4	43
Salisbury, . .	do.	15	do.	do.	51 4	−1 48	186
Babbacombe, .	do.	15	do.	9 : 9	50 29	−3 31	293
Barnstaple, . .	do.	15	do.	M.P.	51 5	−4 3	43
Falmouth, . .	do.	15	do.	hourly	50 9	−5 4	211
Scilly, . . .	do.	15	do.	8 :	49 55	−6 18	100
Guernsey, . .	do.	15	do.	M.P.	49 28	−2 32	204
Jersey, . . .	do.	15	do.	9 : 9	49 12	−2 7	50

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·676	29·674	29·723	29·733	29·810	29·754	29·700	29·715	29·717	29·648	29·633	29·653	29·703	...
29·530	29·509	29·572	29·558	29·646	29·618	29·562	29·567	29·564	29·505	29·476	29·504	29·551	...
29·722	29·741	29·806	29·799	29·880	29·837	29·778	29·788	29·790	29·719	29·712	29·724	29·774	...
29·845	29·834	29·880	29·877	29·966	29·913	29·859	29·864	29·870	29·803	29·790	29·811	29·859	...
29·727	29·710	29·764	29·753	29·836	29·803	29·747	29·759	29·567	29·711	29·676	29·706	29·746	...
29·645	29·632	29·672	29·673	29·756	29·704	29·656	29·663	29·669	29·611	29·592	29·602	29·656	...
29·156	29·143	29·189	29·187	29·274	29·227	29·177	29·191	29·193	29·131	29·127	29·124	29·176	...
29·828	29·825	29·868	29·883	29·958	29·912	29·847	29·858	29·859	29·804	29·774	29·784	29·850	...
29·730	29·732	29·766	29·783	29·857	29·811	29·749	29·760	29·763	29·705	29·682	29·692	29·752	...
29·320	29·315	29·331	29·346	29·427	29·381	29·329	29·334	29·339	29·286	29·253	29·269	29·328	...
29·213	29·202	29·222	29·237	29·320	29·277	29·222	29·234	29·232	29·182	29·148	29·166	29·221	...
29·667	29·644	29·678	29·668	29·754	29·702	29·650	29·665	29·667	29·619	29·596	29·626	29·661	...
29·792	29·772	29·806	29·800	29·881	29·830	29·778	29·788	29·792	29·741	29·720	29·748	29·787	...
29·507	29·485	29·540	29·513	29·618	29·585	29·537	29·551	29·547	29·501	29·450	29·481	29·526	...
29·750	29·738	29·758	29·748	29·833	29·784	29·746	29·741	29·754	29·699	29·675	29·702	29·744	...
29·920	29·870	29·910	29·882	29·977	29·932	29·896	29·888	29·893	29·846	29·842	29·853	29·892	...
29·891	29·897	29·895	29·881	29·973	29·931	29·865	29·879	29·883	29·837	29·810	29·831	29·881	...
29·933	29·901	29·922	29·900	29·990	29·950	29·897	29·916	29·914	29·870	29·852	29·876	29·910	...
29·939	29·910	29·914	29·890	29·988	29·944	29·907	29·912	29·900	29·868	29·837	29·842	29·904	...
29·508	29·470	29·498	29·470	29·570	29·522	29·485	29·471	29·496	29·440	29·414	29·456	29·483	...
29·715	29·671	29·701	29·667	29·771	29·730	29·703	29·681	29·689	29·646	29·626	29·662	29·689	...
29·978	29·933	29·933	29·894	30·000	29·962	29·913	29·925	29·922	29·887	29·868	29·908	29·927	...
29·978	29·940	29·950	29·903	29·998	29·962	29·925	29·930	29·936	29·892	29·878	29·914	29·934	...
29·822	29·775	29·817	29·778	29·884	29·841	29·802	29·788	29·808	29·756	29·731	29·777	29·798	...
29·901	29·868	29·918	29·867	29·990	29·948	29·921	29·909	29·907	29·850	29·824	29·861	29·897	...
29·537	29·482	29·500	29·438	29·554	29·522	29·502	29·500	29·518	29·463	29·445	29·484	29·495	—·030
29·986	29·926	29·944	29·882	29·998	29·962	29·930	29·923	29·928	29·890	29·872	29·920	29·930	—·020
28·935	29·897	29·946	29·872	29·988	29·958	29·933	29·925	29·925	29·867	29·856	29·899	29·917	...
29·989	29·928	29·953	29·875	30·000	29·961	29·943	29·935	29·940	29·900	29·880	29·935	29·945	...
29·982	29·925	29·943	29·880	29·994	29·955	29·916	29·919	29·927	29·885	29·866	29·894	29·924	...
29·767	29·710	29·723	29·664	29·771	29·733	29·710	29·712	29·713	29·675	29·646	29·700	29·710	...
29·976	29·920	29·944	29·880	29·997	29·955	29·916	29·920	29·930	29·885	29·862	29·908	29·924	...
29·980	29·939	29·938	29·898	29·003	29·958	29·913	29·918	29·930	29·898	29·868	29·896	29·928	...
29·926	29·883	29·877	29·846	29·933	29·900	29·860	29·865	29·870	29·820	29·807	29·855	29·870	...
29·933	29·888	29·870	29·822	29·928	29·892	29·848	29·850	29·870	29·837	29·808	29·836	29·865	...
29·703	29·644	26·655	29·598	29·720	29·688	29·650	29·654	29·657	29·605	29·571	29·619	29·647	—·020
29·833	29·774	29·776	29·717	29·828	29·795	29·770	29·768	29·776	29·731	29·711	29·756	29·770	...
29·986	29·926	29·929	29·864	29·969	29·936	29·911	29·908	29·917	29·876	29·857	29·904	29·915	...
30·022	29·960	29·950	29·900	30·006	29·985	29·960	29·960	29·960	29·907	29·890	29·944	29·956	...
30·022	29·965	29·953	29·893	30·003	29·978	29·958	29·961	29·953	29·913	29·890	29·940	29·952	...
29·818	29·747	29·739	29·672	29·796	29·748	29·736	29·755	29·739	29·701	29·691	29·734	29·740	...
29·824	29·767	29·774	29·707	29·823	29·793	29·776	29·774	29·773	29·722	29·713	29·761	29·767	...
29·929	29·898	29·928	29·843	29·967	29·936	29·916	29·907	29·902	29·848	29·853	29·900	29·902	...
29·804	29·743	29·756	29·692	29·810	29·781	29·754	29·750	29·753	29·706	29·676	29·739	29·747	...
30·016	29·960	29·980	29·901	30·026	30·002	29·984	29·978	29·968	29·934	29·915	29·974	29·971	...
29·949	29·884	29·912	29·838	29·956	29·928	29·904	29·895	29·895	29·851	29·849	29·888	29·896	...
29·771	29·714	29·747	29·666	29·796	29·776	29·758	29·752	29·736	29·686	29·678	29·727	29·734	...
29·973	29·922	29·957	29·875	30·017	29·993	29·976	29·964	29·951	29·894	29·896	29·940	29·947	...
29·803	29·744	29·750	29·670	29·796	29·784	29·777	29·767	29·771	29·697	29·689	29·759	29·751	...
29·984	29·926	29·921	29·843	29·958	29·950	29·954	29·935	29·926	29·877	29·864	29·925	29·922	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Sydvaranger, .	Norway	15	1870–84	8: 2, 8	69 40	30 11	67
Vardö, . .	do.	15	do.	8: 1, 8	70 22	31 7	33
Gjaesvaer, . .	do.	15	do.	8: 2, 8	71 7	25 22	22
Alten, . . .	do.	15	do.	do.	69 58	23 17	43
Tromsö, . .	do.	15	do.	do.	69 39	18 58	50
Lödingen, . .	do.	15	do.	do.	68 24	16 1	44
Fagerness, . .	do.	15	do.	do.	68 27	17 28	25
Bodö, . . .	do.	15	do.	do.	67 17	14 24	15
Bronö, . . .	do.	15	do.	do.	65 28	12 12	34
Christiansund, .	do.	15	do.	do.	63 7	7 45	50
Aalesund, . .	do.	15	do.	do.	62 29	6 9	47
Florö, . . .	do.	15	do.	$7\frac{1}{2}$: 2, 8	61 36	5 2	26
Leirdal, . .	do.	15	do.	8: 2, 8	61 6	7 27	16
Bergen, . .	do.	15	do.	do.	60 24	5 20	57
Skudesnes, . .	do.	15	do.	do.	59 9	5 16	13
Mandal, . .	do.	15	do.	do.	58 2	7 27	54
Sandösand, . .	do.	15	do.	do.	59 5	10 28	27
Christiania, . .	do.	15	do.	do.	59 55	10 43	81
Dovre, . . .	do.	15	do.	do.	62 5	9 8	2110
Haparanda, . .	Sweden	15	do.	8: 2, 9	65 50	24 9	30
Piteå, . . .	do.	15	do.	do.	65 19	21 30	34
Stensele, . .	do.	15	do.	do.	65 5	17 0	1106
Umeå, . . .	do.	15	do.	do.	63 49	20 18	41
Hernösand, . .	do.	15	do.	do.	62 38	17 58	45
Oestersund, . .	do.	15	do.	do.	63 11	14 38	972
Husâ, . . .	do.	15	do.	do.	63 32	13 07	1260
Sweg, . . .	do.	15	do.	do.	62 2	14 23	1050
Fahlun, . .	do.	15	do.	do.	60 36	15 37	380
Upsala, . .	do.	15	do.	hourly	59 52	17 38	79
Stockholm, . .	do.	15	do.	8: 2, 9	59 20	18 4	146
Carlstadt, . .	do.	15	do.	do.	59 23	13 30	179
Göteborg, . .	do.	15	do.	do.	57 42	11 59	22
Jönköping, . .	do.	15	do.	do.	57 47	14 11	321
Wisby, . .	do.	15	do.	do.	57 39	18 19	52
Kalmar, . .	do.	15	do.	do.	56 40	16 23	31
Carlshamn, . .	do.	15	do.	do.	56 10	14 52	31
Halmstad, . .	do.	15	do.	do.	56 40	12 52	34
Skagen, . .	Denmark	15	do.	do.	57 44	10 38	10
Vestervig, . .	do.	15	do.	do.	56 47	8 20	82
Fanö, . . .	do.	15	do.	do.	55 27	8 24	18
Herning, . .	do.	15	do.	do.	56 8	8 58	195
Samsö, . .	do.	15	do.	do.	55 50	10 36	66
Copenhagen, .	do.	15	do.	do.	55 41	12 36	44
Bogö, . . .	do.	15	do.	do.	54 55	12 4	88
Hammershus, .	do.	15	do.	do.	55 17	14 40	50
Groningen, . .	Holland	15	do.	8: 2, 8	53 13	6 34	49
Leeuwarden, .	do.	15	do.	do.	53 12	5 47	24
Helder, . .	do.	15	do.	do.	52 57	4 40	14
Amsterdam, . .	do.	15	do.	do.	52 22	4 53	0
Utrecht, . .	do.	15	do.	8: 2, 10	52 5	5 7	44

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·569	29·644	29·575	29·750	29·808	29·780	29·738	29·729	29·691	29·617	29·622	29·599	29·677	...
29·536	29·623	29·570	29·756	29·833	29·812	29·776	29·758	29·716	29·622	29·616	29·582	29·683	...
29·536	29·603	29·576	29·773	29·833	29·841	29·787	29·769	29·687	29·621	29·603	29·541	29·681	...
29·555	29·640	29·607	29·777	29·805	29·810	29·751	29·737	29·702	29·618	29·600	29·588	29·683	...
29·509	29·601	29·555	29·741	29·811	29·806	29·746	29·748	29·668	29·643	29·617	29·575	29·668	+·020
29·536	29·647	29·612	29·775	29·789	29·799	29·730	29·744	29·683	29·632	29·612	29·569	29·677	...
29·561	29·677	29·638	29·801	29·809	29·819	29·753	29·768	29·717	29·659	29·642	29·602	29·704	...
29·608	29·695	29·655	29·812	29·818	29·826	29·758	29·770	29·726	29·671	29·661	29·607	29·717	...
29·637	29·713	29·677	29·816	29·814	29·825	29·750	29·767	29·744	29·674	29·660	29·617	29·725	...
29·650	29·714	29·697	29·811	29·814	29·805	29·731	29·733	29·723	29·667	29·653	29·611	29·717	...
29·662	29·717	29·697	29·808	29·819	29·803	29·731	29·739	29·725	29·675	29·650	29·618	29·720	...
29·737	29·787	29·757	29·852	29·852	29·833	29·761	29·765	29·765	29·717	29·675	29·685	29·766	...
29·765	29·843	29·816	29·896	29·840	29·819	29·745	29·776	29·775	29·754	29·755	29·769	29·796	...
29·748	29·783	29·750	29·824	29·830	29·809	29·741	29·762	29·750	29·717	29·682	29·682	29·757	...
29·815	29·830	29·805	29·866	29·875	29·851	29·774	29·787	29·814	29·754	29·730	29·744	29·804	...
29·838	29·852	29·798	29·842	29·843	29·816	29·756	29·767	29·786	29·766	29·729	29·747	29·795	...
29·857	29·889	29·813	29·864	29·842	29·817	29·753	29·773	29·794	29·791	29·762	29·776	29·811	...
29·779	29·820	29·748	29·795	29·757	29·739	29·680	29·701	29·723	29·723	29·692	29·709	29·739	...
27·488	27·538	27·489	27·586	27·593	27·615	27·572	27·578	27·568	27·512	27·472	27·447	27·538	...
29·746	29·839	29·734	29·860	29·855	29·839	29·778	29·793	29·807	29·774	29·761	29·746	29·795	...
29·744	29·833	29·763	29·862	29·863	29·826	29·775	29·781	29·810	29·757	29·756	29·745	29·793	...
28·536	28·622	28·570	28·660	28·671	28·660	28·630	28·646	28·613	28·555	28·546	28·544	28·804	...
29·773	29·836	29·763	29·858	29·833	29·822	29·760	29·782	29·794	29·743	29·750	29·742	29·788	...
29·793	29·873	29·769	29·856	29·823	29·814	29·752	29·770	29·781	29·776	29·756	29·752	29·793	...
28·694	28·780	28·725	28·805	28·805	28·779	28·752	28·768	28·737	28·701	28·688	28·682	28·743	+·030
28·368	28·410	28·362	28·480	28·494	28·480	28·455	28·466	28·429	28·390	28·349	28·329	28·418	...
28·565	28·584	28·584	28·563	28·625	28·608	28·573	28·618	28·603	28·575	28·540	28·534	28·581	...
29·432	29·489	29·412	29·475	29·445	29·431	29·375	29·406	29·415	29·411	29·371	29·377	29·420	...
29·817	29·843	29·756	29·815	29·785	29·778	29·720	29·743	29·766	29·771	29·725	29·722	29·770	...
29·739	29·775	29·685	29·751	29·721	29·727	29·663	29·695	29·714	29·707	29·660	29·651	29·707	+·040
29·678	29·734	29·645	29·694	29·674	29·666	29·590	29·608	29·630	29·640	29·598	29·604	29·647	—·055
29·912	29·922	29·847	29·886	29·884	29·854	29·808	29·816	29·845	29·841	29·795	29·809	29·852	...
29·557	29·595	29·523	29·559	29·547	29·531	29·483	29·505	29·524	29·513	29·458	29·464	29·522	—·025
29·875	29·893	29·803	29·844	29·843	29·820	29·776	29·782	29·807	29·829	29·778	29·773	29·819	+·020
29·946	29·934	29·853	29·884	29·901	29·865	29·822	29·822	29·866	29·878	29·812	29·820	29·867	+·030
29·954	29·953	29·863	29·887	29·897	29·870	29·832	29·860	29·897	29·875	29·817	29·837	29·879	...
29·878	29·918	29·840	29·860	29·872	29·853	29·825	29·826	29·858	29·845	29·792	29·802	29·847	...
29·917	29·927	29·862	29·906	29·908	29·870	29·831	29·821	29·852	29·848	29·802	29·813	29·863	...
29·843	29·833	29·772	29·806	29·823	29·806	29·756	29·753	29·776	29·760	29·705	29·733	29·779	...
29·954	29·930	29·875	29·886	29·930	29·906	29·863	29·851	29·867	29·845	29·802	29·836	29·879	...
29·753	29·721	29·662	29·686	29·713	29·693	29·646	29·646	29·662	29·650	29·600	29·630	29·672	...
29·908	29·890	29·832	29·853	29·870	29·856	29·812	29·814	29·833	29·817	29·766	29·794	29·837	...
29·936	29·918	29·851	29·871	29·884	29·867	29·831	29·837	29·859	29·843	29·804	29·819	29·860	...
29·912	29·882	29·820	29·835	29·850	29·828	29·804	29·804	29·825	29·806	29·762	29·788	29·833	...
29·956	29·922	29·853	29·864	29·873	29·878	29·847	29·838	29·886	29·873	29·808	29·831	29·870	...
29·955	29·928	29·887	29·855	29·942	29·906	29·883	29·876	29·884	29·854	29·822	29·861	29·888	...
30·010	29·973	29·931	29·904	29·938	29·926	29·927	29·921	29·937	29·904	29·863	29·906	29·928	...
30·000	29·960	29·930	29·898	29·986	29·953	29·946	29·920	29·926	29·888	29·850	29·895	29·929	...
29·989	29·966	29·928	29·886	29·977	29·953	29·927	29·919	29·931	29·894	29·862	29·898	29·928	...
30·010	29·956	29·923	29·878	29·966	29·941	29·941	29·910	29·924	29·892	29·862	29·900	29·926	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Hellevoetsluis, .	Holland	15	1870–84	8 : 2, 8	51 50	4 7	0
Flushing, . .	do.	15	do.	do.	51 26	3 35	0
Maestricht, . .	do.	15	do.	8 : 2, 7	50 52	5 37	174
Luxemburg, . .	do.	15	do.	8 : 2, 8	49 37	6 8	1020
Ostend, . .	Belgium	15	do.	9 : 3	51 14	2 55	27
Brussels, . .	do.	15	do.	do.	50 51	4 22	186
Liege, . . .	do.	15	do.	do.	50 41	5 33	199
Amiens, . .	France	15	do.	M.P.	49 54	1 18	102
Nancy, . .	do.	15	do.	do.	48 42	6 11	725
Mirecourt, . .	do.	15	do.	do.	48 18	6 8	974
Troyes, . .	do.	15	do.	do.	48 18	4 5	348
Chalons-sur-Marne,	do.	15	do.	do.	48 57	4 21	294
Paris, . . .	do.	15	do.	do.	48 48	2 21	256
Versailles, . .	do.	15	do.	do.	48 48	2 7	421
Rouen, . .	do.	15	do.	do.	49 26	1 5	39
Fécamp, . .	do.	15	do.	Noon.	49 46	0 22	61
Caen, . . .	do.	15	do.	M.P.	49 11	−0 21	69
S. Honorine-du-Fay,	do.	15	do.	do.	49 5	−0 30	388
Alençon, . .	do.	15	do.	do.	48 26	0 5	475
Le Mans, . .	do.	15	do.	do.	48 1	0 12	285
Rennes, . .	do.	15	do.	do.	48 7	−1 41	106
Lamballe, . .	do.	15	do.	do.	48 28	−2 31	252
Brest, . .	do.	15	do.	do.	48 23	−4 30	210
L'Orient, . .	do.	15	do.	do.	47 45	−3 21	86
Nantes, . .	do.	15	do.	do.	47 13	−1 33	136
Angers, . .	do.	15	do.	do.	47 28	−0 34	153
Poitiers, . .	do.	15	do.	do.	46 35	−0 40	384
Orléans, . .	do.	15	do.	do.	47 54	1 54	357
Bourges, . .	do.	15	do.	do.	47 5	2 24	510
Clermont Ferrand,	do.	15	do.	do.	45 47	3 5	1296
Limoges, . .	do.	15	do.	do.	45 50	1 15	842
Le Roche-sur-Yon,	do.	15	do.	do.	46 40	−1 26	198
Rochebonne, .	do.	15	do.	do.	46 12	−2 20	0
La Grande-Sauve,	do.	15	do.	do.	44 46	−0 19	331
St. Martin de Hinx,	do.	15	do.	do.	43 35	−1 16	131
Lescar, . .	do.	15	do.	do.	43 20	−0 26	524
Périgueux, . .	do.	15	do.	do.	45 11	0 43	291
Albi, . . .	do.	15	do.	do.	43 56	2 8	574
Toulouse, . .	do.	15	do.	do.	43 37	1 26	636
Foix, . . .	do.	15	do.	do.	42 58	1 36	1421
Perpignan, . .	do.	15	do.	do.	42 42	2 53	104
Carcassonne, .	do.	15	do.	do.	43 13	2 19	384
Rodez, . . .	do.	15	do.	do.	44 21	2 34	2050
Besançon, . .	do.	15	do.	do.	47 14	6 2	845
Bourg, . . .	do.	15	do.	do.	46 12	5 13	822
Lyons, . . .	do.	15	do.	do.	45 46	4 49	637
Grenoble, . .	do.	15	do.	do.	45 12	5 43	714
Privas, . .	do.	15	do.	do.	44 44	4 36	997
Montpellier, . .	do.	15	do.	do.	43 37	3 53	121
Avignon, . .	do.	15	do.	do.	43 57	4 48	72

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·028	29·984	29·958	29·891	29·995	29·972	29·947	29·937	29·952	29·916	29·883	29·928	29·949	...
30·030	29·991	29·950	29·906	29·995	29·975	29·954	29·938	29·958	29·920	29·888	29·933	29·953	−·020
29·885	29·839	29·788	29·725	29·812	29·805	29·775	29·791	29·811	29·776	29·749	29·792	29·796	...
28·961	28·926	28·870	28·806	28·898	28·910	28·918	28·902	28·928	28·878	28·847	28·883	28·894	...
30·016	29·946	29·942	29·886	29·981	29·950	29·961	29·922	29·942	29·886	29·878	29·930	29·936	...
29·858	29·802	29·770	29·710	29·806	29·786	29·794	29·768	29·789	29·739	29·723	29·775	29·777	+·020
29·822	29·765	29·758	29·697	29·793	29·777	29·785	29·755	29·777	29·730	29·714	29·766	29·762	+·035
29·976	29·922	29·894	29·822	29·906	29·910	29·906	29·902	29·902	29·878	29·835	29·886	29·895	...
29·339	29·272	29·245	29·115	29·245	29·249	29·256	29·237	29·276	29·213	29·213	29·237	29·241	...
29·056	28·997	28·961	28·851	28·949	28·965	28·997	28·985	28·985	28·945	28·926	29·001	28·968	...
29·731	29·680	29·629	29·530	29·633	29·644	29·656	29·644	29·633	29·593	29·597	29·620	29·633	...
29·811	29·725	29·682	29·587	29·676	29·678	29·678	29·678	29·685	29·665	29·634	29·705	29·683	...
29·831	29·764	29·720	29·633	29·740	29·739	29·736	29·724	29·736	29·702	29·683	29·741	29·727	...
29·641	29·566	29·527	29·448	29·542	29·546	29·554	29·550	29·542	29·530	29·507	29·556	29·542	+·030
30·052	29·981	29·950	29·876	29·970	29·958	29·965	29·953	29·961	29·918	29·900	29·957	29·953	...
29·977	29·916	29·888	29·828	29·936	29·926	29·915	29·928	29·863	29·851	29·840	29·903	29·898	+·030
29·977	29·898	29·894	29·812	29·922	29·914	29·938	29·886	29·878	29·855	29·859	29·898	29·894	...
29·654	29·587	29·590	29·489	29·603	29·600	29·603	29·591	29·587	29·532	29·532	29·580	29·579	...
29·567	29·501	29·479	29·376	29·490	29·497	29·516	29·493	29·497	29·438	29·446	29·490	29·483	...
29·800	29·741	29·717	29·634	29·718	29·729	29·737	29·725	29·721	29·678	29·686	29·733	29·718	...
29·982	29·903	29·879	29·789	29·907	29·911	29·918	29·903	29·907	29·871	29·840	29·907	29·893	...
29·784	29·717	29·717	29·634	29·753	29·757	29·761	29·749	29·762	29·697	29·670	29·745	29·729	...
30·059	30·009	30·031	29·920	30·056	30·045	30·075	30·020	30·033	29·946	29·973	30·018	30·015	...
30·086	30·030	30·028	29·923	30·066	30·038	30·080	30·023	30·038	29·958	29·995	30·032	30·025	...
29·980	29·908	29·875	29·770	29·898	29·904	29·908	29·892	29·884	29·837	29·855	29·910	29·885	...
29·946	29·895	29·848	29·737	29·855	29·875	29·875	29·871	29·867	29·808	29·816	29·863	29·855	...
29·701	29·646	29·600	29·512	29·611	29·650	29·670	29·638	29·619	29·571	29·580	29·634	29·620	...
29·725	29·670	29·630	29·512	29·622	29·646	29·650	29·630	29·623	29·591	29·611	29·638	29·630	...
29·558	29·507	29·455	29·357	29·467	29·499	29·503	29·479	29·463	29·428	29·440	29·487	29·470	...
28·720	28·674	28·607	28·524	28·630	28·646	28·682	28·658	28·666	28·603	28·615	28·628	28·637	...
29·166	29·134	29·103	29·000	29·115	29·154	29·189	29·142	29·127	29·107	29·119	29·134	29·124	...
29·886	29·843	29·812	29·694	29·784	29·827	29·843	29·831	29·839	29·756	29·792	29·828	29·811	...
30·098	30·080	30·034	29·926	29·994	30·086	30·086	30·042	30·030	29·965	30·026	30·064	30·036	...
29·769	29·721	29·658	29·564	29·654	29·710	29·717	29·706	29·710	29·639	29·666	29·717	29·686	+·020
30·016	29·956	29·892	29·808	29·890	29·938	29·946	29·922	29·914	29·888	29·898	29·953	29·918	...
29·567	29·512	29·461	29·363	29·441	29·497	29·516	29·469	29·488	29·441	29·465	29·512	29·478	...
29·796	29·764	29·705	29·611	29·693	29·745	29·760	29·725	29·721	29·686	29·725	29·733	29·722	...
29·528	29·468	29·398	29·304	29·383	29·438	29·454	29·434	29·442	29·418	29·424	29·438	29·427	...
29·449	29·402	29·331	29·233	29·323	29·382	29·402	29·378	29·394	29·339	29·351	29·382	29·364	...
28·607	28·564	28·508	28·406	28·508	28·560	28·595	28·580	28·578	28·520	28·532	28·556	28·543	−·020
30·012	29·969	29·886	29·784	29·871	29·918	29·922	29·918	29·930	29·898	29·906	29·930	29·912	...
29·721	29·690	29·611	29·510	29·591	29·634	29·658	29·634	29·650	29·607	29·632	29·638	29·632	+·020
27·934	27·906	27·835	27·756	27·867	27·934	27·965	27·941	27·922	27·864	27·851	27·863	27·887	...
29·237	29·174	29·111	29·012	29·103	29·134	29·146	29·142	29·162	29·123	29·079	29·127	29·129	−·020
29·246	29·191	29·124	29·018	29·112	29·140	29·170	29·152	29·170	29·128	29·112	29·160	29·144	−·030
29·450	29·392	29·313	29·218	29·305	29·333	29·351	29·346	29·367	29·331	29·326	29·367	29·342	...
29·362	29·298	29·212	29·113	29·197	29·245	29·272	29·252	29·284	29·241	29·245	29·292	29·241	...
29·056	29·012	28·930	28·843	28·934	28·977	28·997	28·981	28·981	28·949	28·957	28·977	28·967	...
29·985	29·926	29·867	29·760	29·843	29·890	29·910	29·871	29·894	29·863	29·882	29·890	29·882	...
30·060	30·000	29·922	29·812	29·894	29·930	29·945	29·926	29·953	29·926	29·942	29·969	29·940	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Marseilles, . .	France	15	1870–84	M.P.	43 17	5 22	246
Barcelonette, .	do.	15	do.	do.	44 23	6 39	3714
Nice, . . .	do.	15	do.	do.	43 42	7 17	89
Ajaccio, . .	do.	15	do.	do.	41 55	8 44	60
Cape Corsica, .	do.	15	do.	do.	43 2	9 22	318
San Sebastian, .	Spain	15	do.	do.	43 19	−2 0	82
Bilbao, . . .	do.	15	do.	do.	43 15	−2 56	52
Santander, . .	do.	15	do.	do.	43 29	−3 50	130
Oviedo, . .	do.	15	do.	do.	43 23	−5 55	738
Corunna, . .	do.	15	do.	do.	43 22	−8 25	82
Santiago, . .	do.	15	do.	do.	42 53	−8 34	863
Salamancha, .	do.	15	do.	do.	40 58	−5 41	2671
Valladolid, . .	do.	15	do.	do.	41 39	−4 44	2346
Burgos, . .	do.	15	do.	do.	42 20	−3 43	2822
Huesca, . .	do.	15	do.	do.	42 7	−0 27	1598
Zaragoza, . .	do.	15	do.	do.	41 38	−0 54	656
Barcelona, . .	do.	15	do.	do.	41 23	2 9	69
Valencia, . .	do.	15	do.	do.	39 28	−0 23	59
Alicante, . .	do.	15	do.	do.	38 21	−0 30	46
Albacete, . .	do.	15	do.	do.	39 0	−1 52	2251
Madrid, . .	do.	15	do.	do.	40 24	−3 42	2149
Ciudad Real, .	do.	15	do.	do.	38 59	−3 57	2090
Badajoz, . .	do.	15	do.	do.	38 54	−6 59	561
Jaén, . . .	do.	15	do.	do.	37 47	−3 36	1926
Granada, . .	do.	15	do.	do.	37 11	−3 39	2198
Seville, . .	do.	15	do.	do.	37 23	−6 1	98
Tarifa, . . .	do.	15	do.	do.	36 0	−5 35	46
San Fernando, .	do.	15	do.	do.	36 28	−6 13	92
Gibraltar, . .	do.	15	do.	do.	36 6	−5 20	53
Malaga, . .	do.	15	do.	do.	36 43	−3 57	75
Cartagena, . .	do.	15	do.	do.	37 36	−0 47	20
Murcia, . .	do.	15	do.	do.	37 59	−0 39	138
Palma, . . .	do.	15	do.	do.	39 33	2 37	66
Lerida, . .	do.	15	do.	do.	41 38	0 52	492
Pontevedra, . .	do.	15	do.	do.	42 26	−8 38	39
La Guardia, . .	do.	15	do.	do.	41 25	−8 49	26
Oporto, . .	Portugal	15	do.	do.	41 9	−8 29	279
Coimbra, . .	do.	15	do.	do.	40 12	−8 30	463
Campo Maior, .	do.	15	do.	do.	39 2	−6 59	945
Lisbon, . .	do.	15	do.	do.	38 42	−9 8	335
Lagos, . . .	do.	15	do.	do.	37 6	−8 38	43
Basel, . . .	Switzerland	15	do.	7 : 1, 9	47 33	7 35	912
Zurich, . . .	do.	15	do.	do.	47 23	8 33	1575
Berne, . . .	do.	15	do.	two-hourly	46 57	7 26	1880
Geneva, . . .	do.	15	do.	do.	46 12	6 9	1335
Gt. St. Bernard, .	do.	15	do.	do.	45 52	7 11	8130
Lugano, . . .	do.	15	do.	7 : 1, 9	46 0	8 57	902
Milan, . . .	Italy	15	do.	9 : 3, 9	45 28	9 11	482
Turin, . . .	do.	15	do.	do.	45 3	7 41	906
Mondovi, . .	do.	15	do.	do.	44 23	7 48	1824

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·842	29·798	29·708	29·617	29·712	29·743	29·755	29·747	29·755	29·730	29·743	29·711	29·744	+·030
26·189	26·166	26·079	26·044	26·138	26·213	26·268	26·256	26·268	26·178	26·123	26·115	26·170	...
30·028	29·980	29·882	29·801	29·886	29·900	29·890	29·890	29·910	29·876	29·894	29·890	29·902	+·035
29·990	29·958	29·886	29·811	29·874	29·938	29·952	29·920	29·920	29·896	29·896	29·917	29·913	...
29·700	29·678	29·598	29·525	29·587	29·648	29·668	29·652	29·656	29·620	29·620	29·635	29·631	...
30·058	30·021	29·974	29·869	29·946	30·000	30·005	29·969	29·976	29·950	29·964	30·016	29·979	−·035
30·084	30·050	29·994	29·906	29·970	30·025	30·037	30·004	29·995	29·964	29·996	30·045	30·006	−·030
29·985	29·948	29·908	29·815	29·885	29·939	29·967	29·916	29·927	29·881	29·914	29·959	29·920	...
29·296	29·257	29·238	29·158	29·253	29·300	29·317	29·295	29·253	29·241	29·227	29·232	29·248	+·060
30·018	29·953	29·950	29·882	29·965	30·000	30·010	29·964	29·953	29·918	29·922	29·969	29·959	...
29·198	29·103	29·075	29·024	29·071	29·154	29·148	29·130	29·123	29·093	29·099	29·147	29·113	−·035
27·375	27·305	27·256	27·197	27·246	27·317	27·332	27·327	27·312	27·295	27·304	27·321	27·298	−·015
27·705	27·631	27·573	27·524	27·564	27·638	27·652	27·638	27·650	27·592	27·613	27·650	27·620	...
27·192	27·137	27·078	27·019	27·083	27·164	27·188	27·156	27·152	27·110	27·117	27·113	27·126	+·030
28·423	28·376	28·318	28·242	28·324	28·393	28·407	28·400	28·390	28·362	28·358	28·360	28·363	+·050
29·465	29·416	29·347	29·231	29·297	29·347	29·355	29·350	29·342	29·341	29·377	29·395	29·355	+·070
30·075	30·037	29·950	29·881	29·947	29·983	29·991	29·964	29·985	29·947	29·962	29·985	29·976	...
30·101	30·038	29·959	29·876	29·924	29·966	29·966	29·945	29·975	29·952	29·983	30·015	29·975	...
30·100	30·056	29·964	29·895	29·928	29·972	29·976	29·948	29·973	29·966	29·998	30·020	29·983	+·050
27·770	27·746	27·687	27·644	27·661	27·730	27·742	27·732	27·742	27·703	27·718	27·722	27·717	+·025
27·916	27·866	27·770	27·723	27·768	27·827	27·833	27·825	27·839	27·825	27·833	27·851	27·823	...
27·981	27·953	27·843	27·812	27·847	27·896	27·914	27·916	27·914	27·894	27·926	27·910	27·900	...
29·633	29·557	29·447	29·407	29·428	29·465	29·440	29·428	29·441	29·440	29·476	29·522	29·474	+·070
28·176	28·104	28·027	28·004	28·010	28·087	28·087	28·071	28·105	28·085	28·084	28·109	28·071	...
27·868	27·829	27·737	27·715	27·729	27·781	27·797	27·806	27·813	27·781	27·773	27·793	27·785	+·025
30·085	30·045	29·934	29·897	29·916	29·957	29·952	29·935	29·977	29·954	29·977	30·021	29·971	−·020
30·146	30·098	29·983	29·950	29·960	30·019	29·995	29·983	30·019	30·015	30·029	30·060	30·021	...
30·109	30·063	29·943	29·925	29·922	29·968	29·940	29·928	29·961	29·966	29·992	30·039	29·980	...
30·192	30·147	30·042	30·006	30·000	30·034	30·024	30·008	30·043	30·050	30·078	30·122	30·062	...
30·130	30·078	29·956	29·918	29·927	29·960	29·950	29·918	29·963	29·958	29·992	30·030	29·995	−·020
30·126	30·080	30·005	29·936	29·964	30·015	30·015	30·006	30·030	29·998	30·050	30·076	30·024	+·050
29·997	29·963	29·866	29·794	29·837	29·870	29·863	29·855	29·908	29·871	29·906	29·936	29·889	...
30·071	30·018	29·941	29·869	29·921	29·986	30·016	29·988	30·008	29·952	29·964	29·976	29·976	−·040
29·628	29·573	29·491	29·402	29·466	29·519	29·532	29·520	29·632	29·504	29·522	29·572	29·522	+·080
30·110	30·031	29·961	29·927	29·947	30·030	30·020	30·002	30·005	29·980	29·997	30·060	30·004	−·020
30·126	30·065	29·990	29·945	29·953	30·050	30·038	30·016	30·020	30·000	30·015	30·090	30·027	+·020
29·849	29·789	29·705	29·666	29·686	29·775	29·768	29·749	29·750	29·728	29·741	29·803	29·751	+·030
29·663	29·613	29·513	29·484	29·492	29·579	29·569	29·552	29·557	29·546	29·562	29·606	29·561	...
29·189	29·118	29·012	28·976	28·992	29·035	29·035	29·027	29·055	29·051	29·067	29·082	29·053	+·015
29·854	29·786	29·676	29·660	29·666	29·728	29·723	29·705	29·727	29·708	29·727	29·783	29·729	...
30·192	30·126	30·005	30·001	29·993	30·048	30·027	30·021	30·035	30·020	30·044	30·112	30·052	...
29·146	29·079	29·012	28·929	29·022	29·040	29·063	29·045	29·079	29·052	29·034	29·040	20·045	−·020
28·421	28·360	28·291	28·256	28·315	28·346	28·374	28·368	28·380	28·334	28·303	28·324	28·356	−·040
28·102	28·042	27·977	27·902	28·000	28·036	28·067	28·056	28·065	28·012	27·996	28·010	28·022	−·020
28·692	28·629	28·549	28·467	28·551	28·595	28·624	28·615	28·626	28·583	28·579	28·602	28·593	...
22·158	22·112	22·082	22·032	22·210	22·315	22·402	22·381	22·335	22·225	22·110	22·064	22·202	...
29·138	29·074	28·982	28·908	28·984	29·006	29·020	29·012	29·050	29·030	29·020	29·012	29·020	...
29·610	29·548	29·440	29·347	29·422	29·449	29·455	29·453	29·488	29·483	29·483	29·489	29·473	+·020
29·143	29·069	28·983	28·872	28·974	29·001	29·016	29·014	29·047	29·032	29·017	29·029	29·016	...
28·166	28·103	28·028	27·955	28·036	28·075	28·103	28·095	28·119	28·089	28·067	28·048	28·074	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
S. Maurizio, . .	Italy	15	1870–84	9 : 3, 9	43 53	8 3	206
Genoa, . . .	do.	15	do.	do.	44 24	8 55	177
Moncalieri, . .	do.	15	do.	do.	44 59	7 41	846
Cremona, . .	do.	15	do.	do.	45 8	10 3	223
Udine, . . .	do.	15	do.	do.	46 4	13 13	381
Belluno, . .	do.	15	do.	do.	46 8	12 14	1325
Venice, . .	do.	15	do.	do.	45 32	12 20	69
Padua, . . .	do.	15	do.	do.	45 24	11 53	110
Vicenza, . .	do.	15	do.	do.	45 33	11 32	182
Rovigo, . .	do.	15	do.	do.	45 3	11 47	30
Mantua, . .	do.	15	do.	do.	45 10	10 47	131
Modena, . .	do.	15	do.	do.	44 39	10 56	211
Leghorn, . .	do.	15	do.	do.	43 33	10 18	79
Florence, . .	do.	15	do.	do.	43 46	11 15	240
Forli, . . .	do.	15	do.	do.	44 13	12 2	160
Pesaro, . .	do.	15	do.	do.	43 55	12 53	45
Ancona, . .	do.	15	do.	do.	43 37	13 31	99
Perugia, . .	do.	15	do.	do.	43 7	12 23	1706
Rome, . . .	do.	15	do.	do.	41 54	12 29	163
Aquila, . . .	do.	15	do.	do.	42 21	13 24	2411
Chieti, . . .	do.	15	do.	do.	42 22	14 11	1117
Montecasino, .	do.	15	do.	do.	41 31	13 48	1730
Foggio, . .	do.	15	do.	do.	41 27	15 31	287
Naples, . .	do.	15	do.	do.	40 52	14 15	489
Potenza, . .	do.	15	do.	do.	40 39	15 48	2712
Lecce, . . .	do.	15	do.	do.	40 22	18 12	236
Tropea, . .	do.	15	do.	do.	38 43	15 54	189
Cosenza, . .	do.	15	do.	do.	39 19	16 17	840
Reggio, . .	do.	15	do.	do.	38 8	15 39	59
Reporto, . .	do.	15	do.	do.	37 14	15 14	45
Syracuse, . .	do.	15	do.	do.	37 3	15 15	71
Malta, . . .	do.	15	do.	do.	35 53	14 30	70
Girgenti, . .	do.	15	do.	do.	37 41	15 12	837
Palermo, .	do.	15	do.	do.	38 7	13 21	237
Trapani, . .	do.	15	do.	do.	38 43	12 32	88
Cagliari, . .	do.	15	do.	do.	39 30	9 0	180
Dolnja Tuzla, .	Bosnia	15	do.	8 : 2, 8	44 46	18 12	909
Sarajevo, . .	do.	15	do.	do.	43 56	18 26	1801
Mostar, . .	do.	15	do.	do.	42 20	17 49	205
Prisren, . .	Albania	15	do.	7 : 2, 9	42 12	20 43	1434
Janina, . .	Turkey	6	1866–73	9 : 9	39 47	20 57	1580
Constantinople, .	do.	17	1857–73	9 :	41 0	28 59	[0]
Sulina . . .	Bulgaria	15	1870–84	8 : 2, 8	45 9	29 40	6
Sofia, . . .	do.	15	do.	do.	42 32	23 23	1764
Bucharest, . .	do.	15	do.	6 : 2, 9	44 25	26 5	305
Rustschuck, . .	do.	15	do.	7 : 2, 9	43 15	25 56	132
Corfu, . . .	Greece	15	do.	7 : 2, 10	39 38	19 33	98
Athens, . .	do.	15	do.	8 : 2, 9	37 58	23 44	337
Candia, . .	do.	5	1880–85	8 : 2	35 30	24 0	112
Braila, . . .	Hungary	15	1870–84	7 : 2, 9	45 6	27 59	71

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·863	29·819	29·756	29·686	29·733	29·764	29·784	29·764	29·792	29·745	29·725	29·745	29·765	...
29·916	29·851	29·780	29·688	29·760	29·794	29·806	29·786	29·815	29·778	29·760	29·779	29·793	...
29·219	29·148	29·051	28·956	29·038	29·061	29·072	29·066	29·108	29·091	29·092	29·100	29·084	...
29·906	29·826	29·736	29·634	29·688	29·709	29·727	29·713	29·772	29·766	29·762	29·759	29·749	...
29·716	29·650	29·567	29·481	29·552	29·563	29·564	29·576	29·613	29·603	29·579	29·591	29·587	...
28·693	28·627	28·536	28·470	28·556	28·572	28·591	28·599	28·630	28·591	28·575	28·571	28·583	...
30·052	29·993	29·910	29·812	29·871	29·890	29·898	29·878	29·945	29·934	29·926	29·930	29·921	...
30·028	29·957	29·863	29·741	29·835	29·843	29·843	29·839	29·894	29·890	29·894	29·910	29·878	...
29·953	29·882	29·784	29·697	29·764	29·764	29·768	29·772	29·824	29·815	29·808	29·796	29·802	...
30·106	30·029	29·936	29·839	29·919	29·908	29·916	29·912	29·963	29·959	29·968	29·978	29·953	+·030
30·000	29·938	29·827	29·726	29·812	29·815	29·815	29·815	29·867	29·855	29·859	29·875	29·851	...
29·925	29·851	29·745	29·652	29·715	29·731	29·737	29·733	29·784	29·776	29·780	29·800	29·764	...
30·006	29·959	29·884	29·793	29·864	29·900	29·904	29·884	29·904	29·884	29·880	29·896	29·872	+·025
29·839	29·796	29·705	29·625	29·701	29·709	29·725	29·713	29·753	29·725	29·725	29·725	29·728	...
29·950	29·886	29·806	29·720	29·792	29·788	29·794	29·800	29·840	29·833	29·845	29·850	29·828	...
30·060	30·012	29·912	29·829	29·890	29·902	29·910	29·898	29·954	29·940	29·954	29·946	29·934	...
30·006	29·951	29·837	29·770	29·837	29·857	29·853	29·853	29·900	29·880	29·884	29·872	29·875	...
28·254	28·218	28·140	28·081	28·163	28·214	28·226	28·238	28·254	28·200	28·180	28·167	28·195	−·030
29·891	29·867	29·781	29·714	29·781	29·817	29·812	29·804	29·843	29·816	29·812	29·806	29·812	...
27·513	27·475	27·110	27·375	27·461	27·500	27·538	27·530	27·548	27·497	27·461	27·426	27·479	+·020
28·883	28·824	28·726	28·686	28·761	28·800	28·804	28·796	28·830	28·804	28·792	28·772	28·790	+·040
28·221	28·189	28·091	28·075	28·150	28·205	28·215	28·213	28·236	28·189	28·162	28·130	28·191	−·020
29·772	29·725	29·634	29·567	29·627	29·654	29·654	29·648	29·697	29·692	29·682	29·676	29·669	...
29·544	29·520	29·438	29·378	29·431	29·477	29·474	29·463	29·501	29·477	29·470	29·469	29·470	...
27·193	27·166	27·107	27·067	27·150	27·217	27·245	27·237	27·252	27·193	27·146	27·120	27·174	...
29·853	29·796	29·717	29·670	29·713	29·733	29·713	29·713	29·768	29·750	29·750	29·754	29·744	...
29·713	29·693	29·627	29·567	29·631	29·646	29·638	29·630	29·662	29·646	29·640	29·650	29·645	...
29·173	29·134	29·063	29·004	29·066	29·100	29·096	29·087	29·134	29·110	29·091	29·080	29·096	−·020
29·997	29·945	29·863	29·827	29·894	29·918	29·906	29·898	29·941	29·922	29·922	29·902	29·911	+·020
30·063	30·037	29·953	29·910	29·960	29·987	29·972	29·962	30·010	29·993	29·987	29·970	29·983	...
30·016	29·977	29·906	29·855	29·906	29·926	29·902	29·890	29·969	29·945	29·930	29·928	29·929	...
30·076	30·042	29·952	29·910	29·957	29·980	29·972	29·968	30·018	29·990	29·990	29·990	29·987	...
29·146	29·134	29·067	29·032	29·100	29·120	29·108	29·112	29·150	29·120	29·095	29·079	29·105	...
29·808	29·796	29·717	29·654	29·723	29·764	29·756	29·756	29·780	29·750	29·748	29·737	29·749	...
29·970	29·950	29·876	29·817	29·888	29·923	29·915	29·907	29·950	29·911	29·903	29·895	29·909	−·050
29·882	29·860	29·768	29·705	29·780	29·819	29·823	29·819	29·843	29·815	29·800	29·804	29·810	+·040
29·163	29·106	29·008	28·928	28·974	29·004	29·008	29·000	29·046	29·042	29·032	29·038	29·029	...
28·190	28·138	28·055	28·008	28·067	28·115	28·120	28·108	28·150	28·123	28·103	28·100	28·106	...
29·863	29·817	29·730	29·646	29·694	29·730	29·705	29·695	29·772	29·770	29·760	29·780	29·747	...
28·588	28·520	28·446	28·368	28·414	28·456	28·441	28·452	28·484	28·510	28·463	28·472	28·472	...
28·320	28·436	28·185	28·276	28·336	28·314	28·275	28·320	28·389	28·380	28·342	28·325	28·325	...
30·071	30·016	29·906	29·938	29·922	29·878	29·867	29·867	29·985	30·060	30·048	30·056	29·972	...
30·150	30·098	29·992	29·930	29·932	29·894	29·880	29·908	30·016	30·067	30·056	30·020	29·995	...
28·245	28·176	28·110	28·042	28·078	28·126	28·122	28·138	28·170	28·200	28·142	28·136	28·140	...
29·831	29·768	29·672	29·628	29·641	29·652	29·658	29·674	29·761	29·782	29·751	29·721	29·712	...
30·065	30·013	29·896	29·780	29·786	29·752	29·760	29·780	29·876	29·906	29·915	29·907	29·870	...
29·973	29·934	29·812	29·800	29·855	29·844	29·804	29·823	29·883	29·886	29·866	29·875	29·866	...
29·738	29·694	29·623	29·564	29·587	29·581	29·554	29·552	29·634	29·676	29·682	29·658	29·629	...
29·990	29·965	29·890	29·831	29·859	29·851	29·823	29·825	29·908	29·922	29·985	29·924	29·898	...
30·150	30·098	29·992	29·930	29·932	29·894	29·880	29·908	30·016	30·067	30·056	30·020	29·995	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Hermannstadt,	Hungary	15	1870–84	7 : 2, 9	45 47	24 9	1381
Klausenburg,	do.	15	do.	do.	46 45	23 34	1192
Bistritz,	do.	15	do.	do.	47 7	24 30	1204
Sereth,	do.	15	do.	do.	47 57	26 4	1140
Ungvár,	do.	15	do.	do.	48 36	22 18	463
Késmarkt,	do.	15	do.	do.	49 8	20 26	2080
Neusohl,	do.	15	do.	do.	48 44	19 9	1217
Neutra,	do.	15	do.	do.	48 19	18 5	564
Pressburg,	do.	15	do.	do.	48 9	17 6	505
Pápa,	do.	15	do.	do.	47 20	17 28	518
Erlau,	do.	15	do.	do.	47 54	20 23	564
Budapest,	do.	15	do.	do.	47 30	19 2	502
Debreczin,	do.	15	do.	do.	47 31	21 38	453
Orsova,	do.	15	do.	do.	44 42	22 25	174
Temesvar,	do.	15	do.	do.	45 46	21 14	338
Pancsova,	do.	15	do.	do.	44 52	20 39	259
Szegedin,	do.	15	do.	do.	46 15	20 9	289
Neusatz,	do.	15	do.	do.	45 15	19 50	276
Brood,	do.	15	do.	do.	45 9	18 1	328
Kalocsa,	do.	15	do.	do.	46 32	18 58	338
Funfkirchen,	do.	15	do.	do.	46 6	18 14	853
Gr. Kanizsa,	do.	15	do.	do.	46 27	17 0	545
Agram,	do.	15	do.	do.	45 49	15 59	535
Fiume,	do.	15	do.	do.	45 17	14 27	75
Zeng,	do.	15	do.	8 : 2, 8	45 0	14 54	118
Gospic,	do.	15	do.	7 : 2, 9	44 33	15 22	1842
Durazzo,	Austria	15	do.	do.	41 49	19 28	23
Punta d'Ostro,	do.	15	do.	do.	42 27	18 34	210
Ragusa,	do.	15	do.	do.	42 38	18 7	49
Knin,	do.	15	do.	do.	44 2	16 11	1161
Zara,	do.	15	do.	do.	44 7	15 15	37
Lissa,	do.	15	do.	do.	43 5	16 14	79
Semaphor Porer,	do.	15	do.	do.	44 45	13 52	23
Lesina,	do.	15	do.	7 : 2, 10 *a*	43 11	16 27	62
Lussinpiccolo,	do.	15	do.	7 : 2, 9	44 42	14 28	34
Pola,	do.	15	do.	do.	44 52	13 50	105
Trieste,	do.	15	do.	do.	45 39	13 46	85
Görz,	do.	15	do.	do.	45 57	13 37	308
Riva,	do.	15	do.	6 : 2, 10 *c*	45 53	10 50	276
Laibach,	do.	15	do.	6 : 2, 10 *b*	46 3	14 30	943
Graz,	do.	15	do.	7 : 2, 9	47 4	15 28	1129
Klagenfurt,	do.	15	do.	do.	46 37	14 18	1437
Obirgipfel,	do.	5	1880–84	do.	46 30	14 27	6706
Salzburg,	do.	15	1870–84	do.	47 48	13 3	1430
Kremsmünster,	do.	15	do.	6 : 2, 10 *a*	48 4	14 8	1260
Vienna,	do.	15	do.	7 : 2, 9	48 14	16 22	664
Eger,	do.	15	do.	6 : 2, 10	50 5	12 22	1493
Leipa,	do.	15	do.	7 : 2, 10	50 41	14 32	889
Prague,	do.	15	do.	6 : 2, 10	50 5	14 25	660
Brünn,	do.	15	do.	6 : 2, 10 *a*	49 11	16 36	692

a Changed to 7 : 2, 9 in 1880. *b* Changed to 7 : 2, 9 in 1879. *c* Changed to 2 : 2, 9 in 1874.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
28·669	28·610	28·509	28·446	28·499	28·518	28·530	28·540	28·592	28·601	28·579	28·563	28·555	
28·855	28·794	28·688	28·613	28·668	28·668	28·690	28·697	28·754	28·770	28·756	28·746	28·725	...
28·844	28·783	28·674	28·611	28·667	28·671	28·684	28·695	28·747	28·773	28·747	28·731	28·719	...
28·902	28·859	28·749	28·705	28·736	28·756	28·756	28·784	28·830	28·872	28·822	28·800	28·798	...
29·670	29·614	29·489	29·399	29·438	29·439	29·453	29·472	29·535	29·545	29·543	29·535	29·511	...
27·855	27·815	27·737	27·709	27·780	27·792	27·815	27·823	27·863	27·847	27·792	27·764	27·799	...
28·820	28·763	28·664	28·595	28·655	28·660	28·690	28·684	28·733	28·740	28·714	28·713	28·702	...
29·545	29·476	29·365	29·290	29·342	29·339	29·372	29·368	29·424	29·439	29·428	29·431	29·402	...
29·610	29·542	29·438	29·344	29·396	29·407	29·422	29·430	29·482	29·477	29·473	29·481	29·458	...
29·595	29·532	29·426	29·335	29·382	29·398	29·414	29·422	29·476	29·465	29·457	29·465	29·447	...
29·523	29·482	29·360	29·276	29·317	29·324	29·347	29·360	29·414	29·402	29·410	29·398	29·384	...
29·611	29·549	29·435	29·345	29·401	29·391	29·422	29·430	29·482	29·492	29·491	29·496	29·462	...
29·691	29·631	29·518	29·415	29·469	29·466	29·484	29·492	29·561	29·564	29·571	29·578	29·537	...
30·014	29·963	29·819	29·721	29·731	29·729	29·736	29·755	29·832	29·888	29·894	29·883	29·830	...
29·819	29·755	29·639	29·530	29·591	29·594	29·590	29·603	29·667	29·690	29·703	29·703	29·657	...
29·890	29·854	29·719	29·618	29·673	29·677	29·691	29·692	29·747	29·757	29·758	29·783	29·738	...
29·860	29·803	29·679	29·586	29·644	29·638	29·642	29·661	29·720	29·728	29·740	29·735	29·703	...
29·871	29·821	29·703	29·594	29·662	29·660	29·667	29·666	29·732	29·744	29·749	29·754	29·719	...
29·898	29·823	29·654	29·579	29·642	29·634	29·634	29·638	29·698	29·701	29·709	29·729	29·695	−·035
29·804	29·735	29·626	29·520	29·579	29·597	29·598	29·602	29·654	29·678	29·687	29·676	29·646	...
29·221	29·174	29·071	28·987	29·052	29·063	29·082	29·083	29·130	29·130	29·134	29·111	29·111	...
29·562	29·496	29·394	29·294	29·361	29·372	29·392	29·396	29·442	29·436	29·437	29·445	29·420	...
29·580	29·508	29·402	29·317	29·379	29·389	29·404	29·402	29·458	29·447	29·448	29·457	29·433	−·020
30·045	29·996	29·908	29·823	29·890	29·892	29·895	29·885	29·933	29·932	29·932	29·928	29·922	...
29·999	29·928	29·836	29·759	29·829	29·853	29·852	29·845	29·888	29·877	29·857	29·860	29·865	...
28·100	28·064	27·978	27·910	27·990	28·043	28·060	28·060	28·090	28·048	28·023	28·015	28·032	...
30·054	30·009	29·936	29·867	29·904	29·923	29·896	29·898	29·947	29·962	29·948	29·966	29·942	...
29·830	29·802	29·719	29·655	29·698	29·717	29·697	29·693	29·753	29·764	29·736	29·753	29·736	...
30·024	29·991	29·923	29·833	29·871	29·893	29·870	29·876	29·931	29·952	29·929	29·947	29·920	...
28·865	28·819	28·764	28·695	28·766	28·765	28·778	28·771	28·778	28·772	28·748	28·744	28·772	−·075
30·049	29·995	29·901	29·820	29·879	29·901	29·893	29·893	29·950	29·933	29·927	29·933	29·927	+·015
29·965	29·930	29·838	29·775	29·840	29·856	29·852	29·841	29·903	29·886	29·876	29·858	29·840	+·030
30·074	30·030	29·933	29·850	29·915	29·932	29·934	29·920	29·966	29·957	29·945	29·949	29·952	...
30·012	29·976	29·885	29·811	29·871	29·886	29·874	29·869	29·930	29·919	29·907	29·891	29·903	...
30·045	30·005	29·907	29·832	29·899	29·907	29·905	29·887	29·955	29·927	29·931	29·925	29·927	...
29·997	29·940	29·844	29·763	29·827	29·815	29·848	29·833	29·880	29·873	29·870	29·872	29·866	...
30·028	29·977	29·872	29·792	29·858	29·867	29·872	29·861	29·922	29·900	29·901	29·905	29·896	...
29·801	29·743	29·647	29·569	29·632	29·652	29·655	29·649	29·704	29·685	29·675	29·678	29·674	...
29·829	29·796	29·685	29·569	29·644	29·670	29·668	29·657	29·711	29·702	29·712	29·732	29·698	+·020
29·102	29·036	28·933	28·858	28·931	28·945	28·963	28·960	29·008	28·984	28·967	28·984	28·973	...
28·898	28·840	28·747	28·683	28·741	28·752	28·782	28·790	28·822	28·805	28·785	28·780	28·785	+·020
28·592	28·522	28·397	28·336	28·412	28·442	28·469	28·473	28·497	28·473	28·457	28·461	28·461	...
23·398	23·386	23·300	23·256	23·438	23·450	23·568	23·536	23·500	23·398	23·402	23·300	23·410	...
28·566	28·505	28·433	28·351	28·445	28·467	28·487	28·487	28·505	28·468	28·439	28·454	28·467	−·030
28·751	28·685	28·612	28·535	28·617	28·637	28·665	28·658	28·686	28·645	28·622	28·638	28·646	...
29·424	29·346	29·255	29·173	29·237	29·253	29·260	29·261	29·308	29·287	29·276	29·286	29·280	...
28·484	28·416	28·360	28·311	28·396	28·404	28·433	28·422	28·446	28·398	28·366	28·362	28·407	...
29·148	29·079	29·004	28·951	29·021	29·024	29·034	29·033	29·059	29·039	29·012	29·024	29·036	...
29·404	29·340	29·260	29·190	29·259	29·262	29·273	29·271	29·306	29·287	29·252	29·282	29·282	...
29·391	29·321	29·233	29·165	29·220	29·225	29·238	29·248	29·282	29·271	29·249	29·263	29·259	+·040

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Barzdorf,	Austria	15	1870–84	6 : 2, 10 *a*	50 25	17 6	816
Krakau,	do.	15	do.	do.	50 4	19 57	722
Lemberg,	do.	15	do.	7 : 2, 9	49 50	24 1	978
Tarnopol,	do.	15	do.	do.	49 36	25 36	1040
Passau,	Germany	15	do.	8 : 2, 8	48 34	13 28	1024
Regensburg,	do.	15	do.	do.	49 1	12 6	1178
Augsburg,	do.	15	do.	do.	48 22	10 54	1638
Munich,	do.	15	do.	do.	48 9	11 34	1734
Bayreuth,	do.	15	do.	do.	49 57	11 35	1132
Bamberg,	do.	15	do.	do.	49 54	10 54	796
Aschaffenburg,	do.	15	do.	do.	49 59	9 9	450
Friedrichshafen,	do.	15	do.	7 : 2, 9	47 39	9 25	1336
Stuttgart,	do.	15	do.	do.	48 47	9 11	881
Mannheim,	do.	15	do.	do.	49 29	8 27	368
Freiburg,	do.	15	do.	do.	48 0	7 51	955
Carlsruhe,	do.	15	do.	do.	49 0	8 25	404
Heidelberg,	do.	15	do.	do.	49 24	8 42	397
Treves,	do.	15	do.	6 : 2, 10	49 45	6 38	492
Gütersloh,	do.	15	do.	do.	51 54	8 23	266
Aachen,	do.	15	do.	do.	50 47	6 5	581
Trier,	do.	15	do.	do.	49 45	6 38	492
Cologne,	do.	15	do.	do.	50 56	6 57	197
Kassel,	do.	15	do.	do.	51 19	9 30	670
Göttingen,	do.	15	do.	do.	51 32	9 56	492
Leipsig,	do.	15	do.	do.	51 20	12 23	387
Berlin,	do.	15	do.	do.	52 30	13 23	136
Ratibor,	do.	15	do.	do.	50 6	18 13	646
Schneekoppe,	do.	5	1881–85	7 : 2, 9	50 44	15 43	5246
Breslau,	do.	15	1870–84	6 : 2, 10	51 7	17 2	483
Posen,	do.	15	do.	do.	52 25	16 56	268
Bromberg,	do.	15	do.	do.	53 8	18 0	162
Hannover,	do.	15	do.	do.	52 22	9 44	202
Keitum,	do.	15	do.	8 : 2, 8	54 54	8 22	30
Borkum,	do.	15	do.	do.	53 35	6 40	13
Helgoland,	do.	15	do.	6 : 2, 10	54 11	7 51	151
Ottendorf,	do.	15	do.	do.	53 48	8 54	20
Hamburg,	do.	15	do.	8 : 2, 8	53 33	9 58	64
Kiel,	do.	15	do.	6 : 2, 10	54 20	10 8	15
Lübeck,	do.	15	do.	do.	53 51	10 41	66
Putbus,	do.	15	do.	do.	54 21	13 28	174
Stettin,	do.	15	do.	do.	53 25	14 34	128
Swinemünde,	do.	15	do.	8 : 2, 8	53 56	14 16	33
Köslin,	do.	15	do.	7 : 2, 9	54 11	16 11	153
Klaussen,	do.	15	do.	6 : 2, 10	53 48	22 7	472
Dantzic,	do.	15	do.	do.	54 21	18 38	71
Königsberg,	do.	15	do.	7 : 2, 9	54 43	20 30	74
Memel,	do.	15	do.	6 : 2, 10	55 43	21 8	32
Torneå,	Finland.	15	do.	7 : 2, 9	65 51	23 29	170
Uleåborg,	do.	15	do.	do.	65 1	25 8	30
Kuopia,	do.	15	do.	do.	62 54	27 20	290

a Changed to 7 : 2, 9 in 1880.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·190	29·139	29·065	29·014	29·070	29·071	29·081	29·085	29·125	29·100	29·068	29·071	29·093	...
29·342	29·285	29·194	29·139	29·185	29·182	29·199	29·198	29·254	29·244	29·222	29·211	29·221	...
29·056	29·009	28·912	28·866	28·893	28·900	28·908	28·929	28·988	29·000	28·958	28·932	28·946	...
28 983	28·945	28·943	28·814	28·830	28·833	28·824	28·860	28·920	28·938	28·890	28·873	28·878	...
29·024	28·965	28·871	28·788	28·863	28·883	28·910	28·914	28·934	28·902	28·894	28·902	28·896	...
28·849	28·790	28·720	28·640	28·718	28·731	28·751	28·751	28·770	28·740	28·731	28·740	28·744	...
28·343	28·281	28·213	28·141	28·231	28·249	28·274	28·282	28·317	28·267	28·233	28·247	28·256	...
28·264	28·209	28·142	28·071	28·162	28·197	28·229	28·220	28·229	28·182	28·150	28·158	28·184	...
28·882	28·815	28·745	28·686	28·764	28·776	28·792	28·796	28·818	28·776	28·749	28·764	28·772	...
29·260	29·186	29·134	29·067	29·142	29·146	29·154	29·162	29·162	29·134	29·115	29·134	29·150	...
29·627	29·548	29·493	29·422	29·493	29·501	29·504	29·512	29·516	29·504	29·485	29·516	29·518	...
28·686	28·623	28·564	28·473	28·567	28·603	28·627	28·615	28·623	28·583	28·563	28·595	28·594	...
29·213	29·139	29·087	29·013	29·087	29·119	29·127	29·123	29·149	29·113	29·093	29·103	29·114	+ ·020
29·747	29·673	29·606	29·523	29·607	29·620	29·622	29·618	29·640	29·616	29·590	29·634	29·625	...
29·086	29·012	28·956	28·870	28·980	29·010	29·025	29·020	29·032	28·993	28·967	28·986	28·995	...
29·704	29·614	29·558	29·480	29·566	29·574	29·583	29·578	29·600	29·569	29·550	29·584	29·580	...
29·692	29·608	29·556	29·482	29·574	29·570	29·582	29·575	29·596	29·554	29·540	29·580	29·576	...
29·573	29·501	29·443	29·364	29·459	29·463	29·475	29·468	29·485	29·455	29·423	29·464	29·464	...
29·784	29·705	29·670	29·644	29·708	29·703	29·686	29·677	29·696	29·667	29·617	29·647	29·681	...
29·434	29 355	29·332	29·284	29·339	29·360	29·368	29·360	29·364	29·328	29·288	29·343	29·345	+ ·020
29·573	29·502	29·443	29·365	29·459	29·463	29·474	29·468	29·484	29·456	29·423	29·464	29·464	+ ·050
29·872	29·797	29·751	29·693	29·785	29·769	29·754	29·752	29·780	29·760	29·720	29·780	29·768	− ·030
29·343	29·284	29·225	29·186	29·264	29·268	29·264	29·256	29·264	29·241	29·197	29·237	29·252	...
29·536	29·473	29·414	29·371	29·447	29·441	29·436	29·430	29·453	29·418	29·390	29·400	29·434	...
29·672	29·606	29·514	29·494	29·565	29·556	29·558	29·557	29·584	29·560	29·533	29·548	29·565	...
29·945	29·896	29·820	29·783	29·842	29·820	29·806	29·808	29·846	29·823	29·782	29·812	29·832	...
29·371	29·310	29·245	29·186	29·228	29·221	29·233	29·234	29·301	29·266	29·254	29·278	29·261	+ ·035
24·619	24·634	24·520	24·544	24·683	24·713	24·792	24·737	24·703	24·599	24·611	24·512	24·639	...
29·585	29·520	29·448	29·406	29·475	29·445	29·450	29·459	29·499	29·478	29·449	29·465	29·473	...
29·802	29·752	29·668	29·634	29·686	29·663	29·653	29·658	29·700	29·704	29·670	29·670	29·688	...
29·907	29·862	29·787	29·754	29·787	29·759	29·756	29·760	29·808	29·805	29·776	29·775	29·795	+ ·020
29·850	29·798	29·743	29·713	29·779	29·755	29·739	29·745	29·774	29·777	29·703	29·735	29·759	+ ·020
29·962	29·918	29·894	29·906	29·942	29·906	29·882	29·874	29·906	29·867	29·815	29·859	29·894	...
30·004	29·954	29·930	29·902	29·973	29·938	29·922	29·906	29·922	29·898	29·847	29·867	29·922	...
29·839	29·791	29·758	29·746	29·815	29·786	29·748	29·750	29·770	29·722	29·684	29·714	29·759	− ·020
29·964	29·929	29·872	29·863	29·925	29·900	29·872	29·876	29·890	29·866	29·822	29·851	29·886	...
29·979	29·936	29·880	29·866	29·916	29·886	29·860	29·870	29·890	29·873	29·839	29·870	29·889	...
29·992	29·958	29·902	29·892	29·944	29·913	29·888	29·876	29·900	29·875	29·840	29·868	29·904	...
29·967	29·925	29·871	29·860	29·908	29·881	29·846	29·850	29·878	29·846	29·815	29·842	29·874	...
29·837	29·797	29·742	29·731	29·776	29·752	29·731	29·740	29·751	29·728	29·683	29·715	29·749	+ ·020
29·911	29·885	29·814	29·786	29·828	29·804	29·792	29·791	29·831	29·816	29·774	29·782	29·818	− ·020
30·011	29·963	29·901	29·890	29·921	29·901	29·873	29·877	29·922	29·901	29·865	29·881	29·910	...
29·933	29·901	29·829	29·802	29·847	29·814	29·808	29·805	29·849	29·823	29·783	29·795	29·832	...
29·552	29·517	29·425	29·412	29·423	29·405	29·396	29·396	29·452	29·467	29·431	29·440	29·443	...
29·992	29·958	29·885	29·870	29·902	29·869	29·852	29·862	29·901	29·918	29·867	29·849	29·894	...
29·971	29·933	29·861	29·847	29·860	29·832	29·823	29·831	29·881	29·906	29·847	29·836	29·869	...
29·989	29·958	29·883	29·889	29·903	29·870	29·841	29·874	29·916	29·932	29·866	29·863	29·900	...
29·608	29·677	29·588	29·698	29·692	29·662	29·623	29·640	29·651	26·613	29·604	29·593	29·637	...
29·781	29·860	29·762	29·849	29·835	29·820	29·782	29·786	29·808	29·782	29·780	29·760	29·801	+ ·015
29·526	29·568	29·461	29·551	29·535	29·540	29·496	29·501	29·535	29·516	29·497	29·472	29·517	+ ·020

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	Latitude. ′	Longitude. °	Longitude. ′	Height, Feet.
Kaskö, . . .	Finland	15	1870–84	7 : 2, 9	62	20	20	51	25
Tammerfors, .	do.	15	do.	do.	61	30	23	25	299
Viborg, . .	do.	15	do.	do.	60	43	28	26	10
Sordavala, . .	do.	15	do.	do.	61	42	30	22	118
Lampis, . .	do.	15	do.	do.	61	6	24	43	370
Åbo, . . .	do.	15	do.	do.	60	27	21	52	49
Kola, . . .	Russia	15	do.	7 : 1, 9	68	53	33	1	33
Simnjaja Solotiza,	do.	15	do.	do.	65	41	40	14	28
Archangel, . .	do.	15	do.	do.	64	33	40	32	16
Mesen, . . .	do.	15	do.	do.	65	30	44	16	52
Kem, . . .	do.	15	do.	do.	64	57	34	39	41
Powenez, . .	do.	15	do.	do.	62	51	34	49	160
Petrosawodsk, .	do.	15	do.	do.	61	47	34	23	233
Walaam, . .	do.	15	do.	do.	61	23	30	57	149
Schenkursk, . .	do.	15	do.	do.	62	6	42	54	138
Wyetegra, . .	do.	15	do.	do.	61	0	36	27	196
Kargopol, . .	do.	15	do.	do.	61	30	38	57	440
St. Petersburg, .	do.	15	do.	do.	59	56	30	16	19
L. Hogland, . .	do.	15	do.	do.	60	6	26	59	37
Baltischport, .	do.	15	do.	do.	59	21	24	3	28
Novgorod, . .	do.	15	do.	do.	58	31	31	18	62
Dorpat, . .	do.	15	do.	do.	58	23	26	43	223
Pernau, . .	do.	15	do.	do.	58	23	24	30	32
Riga, . . .	do.	15	do.	do.	56	57	24	6	42
Windau, . .	do.	15	do.	do.	57	24	21	33	29
Libau, . . .	do.	15	do.	do.	56	31	21	1	19
Weliki-Luki, .	do.	15	do.	do.	56	21	30	31	358
Wilna, . . .	do.	15	do.	do.	54	41	25	18	387
Belostok, . .	do.	15	do.	do.	53	8	23	10	479
Warsaw, . .	do.	15	do.	do.	52	13	21	2	392
Pinsk, . . .	do.	15	do.	do.	52	7	26	6	459
Gorki, . . .	do.	15	do.	do.	54	17	30	59	679
Tschernigov, .	do.	15	do.	do.	51	29	31	20	424
Kiev, . . .	do.	15	do.	do.	50	27	30	30	600
Gorodischtsche, .	do.	15	do.	do.	49	17	31	27	296
Ssochanskoe, .	do.	15	do.	do.	49	34	28	55	920
Elizabethgrad, .	do.	15	do.	do.	48	31	32	17	417
Charkov, . .	do.	15	do.	do.	50	4	36	9	413
Gulynki, . .	do.	15	do.	do.	54	14	40	0	354
Moscow, . .	do.	15	do.	do.	55	50	37	33	509
Bielosersk, . .	do.	15	do.	do.	60	2	37	47	430
Roschdestwenskoe,	do.	15	do.	do.	58	9	45	36	443
N. Novgorod, .	do.	15	do.	do.	56	20	44	0	453
Nikolsk, . .	do.	15	do.	do.	59	32	45	27	390
Wjatka, . .	do.	15	do.	do.	58	36	49	41	580
Perm, . . .	do.	15	do.	do.	58	1	56	16	328
Blagodat, . .	do.	15	do.	do.	58	17	59	47	1250
Kasan, . . .	do.	15	do.	do.	55	47	49	8	249
Slatoust, . .	do.	15	do.	do.	55	10	59	41	1343
Polibino, . .	do.	15	do.	do.	53	44	52	56	313

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·821	29·885	29·816	29·852	29·839	29·843	29·795	29·811	29·824	29·811	29·788	29·780	29·822	...
29·526	29·587	29·500	29·568	29·530	29·558	29·495	29·498	29·532	29·540	29·497	29·479	29·526	...
29·908	29·952	29·847	29·911	29·872	29·878	29·808	29·833	29·890	29·896	29·876	29·831	29·875	...
29·730	29·772	29·697	29·767	29·725	29·730	29·660	29·713	29·738	29·746	29·715	29·687	29·723	−·040
29·468	29·513	29·434	29·492	29·458	29·468	29·426	29·429	29·479	29·459	29·436	29·398	29·455	...
29·908	29·942	29·858	29·921	29·874	29·882	29·816	29·828	29·864	29·872	29·839	29·828	29·869	−·060
29·658	29·700	29·653	29·814	29·836	29·828	29·783	29·781	29·755	29·716	29·724	29·720	29·748	+·030
29·788	29·815	29·701	29·851	29·835	29·843	29·780	29·788	29·815	29·780	29·750	29·746	29·791	...
29·823	29·843	29·739	29·871	29·829	29·827	29·792	29·801	29·844	29·825	29·802	29·792	29·815	...
29·770	29·806	29·692	29·830	29·800	29·805	29·751	29·767	29·793	29·754	29·738	29·728	29·778	+·050
29·774	29·827	29·712	29·843	29·834	29·823	29·779	29·780	29·815	29·781	29·765	29·749	29·790	...
29·690	29·714	29·601	29·718	29·675	29·683	29·616	29·624	29·680	29·683	29·660	29·626	29·663	−·050
29·634	29·665	29·551	29·646	29·606	29·610	29·555	29·580	29·634	29·650	29·594	29·575	29·608	−·040
29·728	29·760	29·657	29·732	29·701	29·690	29·646	29·677	29·718	29·744	29·685	29·658	29·700	−·040
29·774	29·800	29·700	29·794	29·726	29·712	29·655	29·685	29·762	29·791	29·770	29·698	29·739	...
29·707	29·726	29·620	29·700	29·628	29·644	29·593	29·620	29·684	29·715	29·664	29·630	29·661	−·030
29·408	29·431	29·325	29·416	29·392	29·375	29·336	29·361	29·408	29·451	29·398	29·361	29·388	...
29·924	29·955	29·835	29·893	29·849	29·847	29·795	29·819	29·874	29·901	29·859	29·833	29·865	...
29·884	29·912	29·814	29·880	29·850	29·845	29·785	29·803	29·853	29·861	29·821	29·798	29·842	...
29·886	29·926	29·835	29·888	29·855	29·849	29·789	29·809	29·858	29·868	29·817	29·800	29·848	...
29·908	29·932	29·814	29·877	29·818	29·806	29·775	29·814	29·873	29·916	29·846	29·806	29·849	+·030
29·727	29·747	29·634	29·694	29·653	29·662	29·600	29·627	29·686	29·709	29·656	29·630	29·669	...
29·938	29·955	29·860	29·894	29·867	29·851	29·804	29·823	29·882	29·902	29·878	29·835	29·874	...
29·960	29·960	29·858	29·884	29·868	29·865	29·823	29·856	29·911	29·916	29·878	29·851	29·886	+·030
29·926	29·922	29·827	29·875	29·863	29·847	29·810	29·831	29·875	29·890	29·835	29·833	29·861	...
29·972	29·960	29·885	29·898	29·896	29·865	29·840	29·876	29·923	29·930	29·888	29·860	29·879	...
29·622	29·622	29·521	29·560	29·520	29·496	29·441	29·508	29·587	29·614	29·547	29·508	29·546	−·020
29·624	29·602	29·500	29·504	29·500	29·490	29·461	29·485	29·558	29·588	29·532	29·500	29·529	...
29·544	29·516	29·433	29·403	29·420	29·416	29·413	29·412	29·493	29·507	29·450	29·438	29·454	...
29·654	29·622	29·568	29·500	29·521	29·518	29·524	29·528	29·588	29·588	29·549	29·540	29·560	+·020
29·595	29·556	29·450	29·406	29·418	29·402	29·382	29·441	29·482	29·529	29·494	29·466	29·468	+·030
29·315	29·297	29·190	29·194	29·182	29·162	29·115	29·193	29·260	29·304	29·245	29·194	29·221	...
29·615	29·591	29·497	29·505	29·457	29·434	29·375	29·430	29·560	29·623	29·565	29·556	29·517	...
29·441	29·418	29·301	29·272	29·268	29·253	29·221	29·276	29·355	29·424	29·375	29·331	29·328	...
29·833	29·766	29·675	29·620	29·612	29·600	29·553	29·576	29·695	29·782	29·738	29·715	29·684	−·030
29·123	29·083	28·977	28·930	28·953	28·945	28·930	28·985	29·024	29·095	29·056	29·012	29·010	...
29·677	29·624	29·522	29·488	29·481	29·460	29·420	29·469	29·592	29·656	29·632	29·591	29·551	−·020
29·663	29·643	29·533	29·490	29·458	29·442	29·395	29·438	29·545	29·677	29·631	29·600	29·543	−·015
29·674	29·682	29·579	29·571	29·520	29·481	29·418	29·489	29·600	29·693	29·662	29·603	29·581	...
29·465	29·473	29·402	29·390	29·343	29·335	29·261	29·320	29·394	29·485	29·445	29·386	29·392	...
29·433	29·475	29·380	29·461	29·403	29·405	29·357	29·381	29·452	29·477	29·416	29·390	29·419	...
29·473	29·521	29·426	29·403	29·422	29·391	29·324	29·386	29·501	29·513	29·513	29·477	29·446	+·020
29·527	29·523	29·491	29·456	29·416	29·353	29·310	29·361	29·480	29·546	29·532	29·503	29·458	+·030
29·512	29·501	29·438	29·534	29·457	29·450	29·382	29·453	29·521	29·552	29·560	29·526	29·491	...
29·319	29·351	29·301	29·343	29·268	29·225	29·170	29·229	29·347	29·367	29·343	29·335	29·300	+·055
29·674	29·666	29·600	29·599	29·556	29·469	29·410	29·473	29·587	29·666	29·686	29·682	29·589	...
28·630	28·600	28·560	28·595	28·575	28·512	28·465	28·520	28·583	28·642	28·634	28·630	28·579	...
29·800	29·784	29·701	29·678	29·603	29·532	29·470	29·544	29·658	29·764	29·784	29·761	29·674	...
28·590	28·558	28·491	28·503	28·468	28·377	28·318	28·405	28·487	28·594	28·574	28·562	28·478	...
29·811	29·776	29·690	29·626	29·563	29·441	29·398	29·461	29·591	29·752	29·792	29·776	29·640	−·020

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	′	Longitude. °	′	Height, Feet.
Simbirsk,	Russia	15	1870–84	7 : 1, 9	54	19	48	24	476
Saratow,	do.	15	do.	do.	51	38	45	27	614
Uralsk,	do.	15	do.	do.	51	43	50	55	358
Orenburg,	do.	15	do.	do.	51	46	55	6	297
Tambov,	do.	15	do.	do.	52	44	41	28	388
Urjupinskaja,	do.	15	do.	do.	50	48	42	0	270
Kamyschin,	do.	15	do.	do.	50	5	45	24	69
Lugan,	do.	15	do.	do.	48	35	39	20	170
Taganrog,	do.	15	do.	do.	47	12	38	59	114
Odessa,	do.	15	do.	do.	46	29	30	44	214
Nikolaev,	do.	15	do.	do.	46	58	31	58	62
L. Tarchankut,	do.	15	do.	do.	45	21	32	31	12
Sebastopol,	do.	15	do.	do.	44	37	33	31	199
Kertsch,	do.	15	do.	do.	45	21	36	29	18
Noworossijsk,	do.	15	do.	do.	44	43	37	46	12
Prischib,	do.	15	do.	do.	45	3	38	55	121
Stawropol,	do.	15	do.	do.	45	3	41	59	1919
Pjatigorsk,	do.	15	do.	do.	44	3	43	5	1667
Wladikawkas,	do.	15	do.	do.	43	2	44	41	2244
Petrowsk,	do.	15	do.	do.	42	59	47	31	−33
Suchum,	do.	15	do.	do.	42	58	40	55	28
Poti,	do.	15	do.	do.	41	36	42	46	24
Batum,	do.	15	do.	do.	41	40	41	38	10
Kutais,	do.	15	do.	do.	42	16	42	42	550
Tiflis,	do.	15	do.	do.	41	43	44	47	1343
Elissawetpol,	do.	15	do.	do.	40	41	46	21	1456
Baku,	do.	15	do.	do.	40	22	49	50	7
Lenkoran,	do.	15	do.	do.	38	46	48	51	−70
Astrabad,	do.	15	do.	do.	36	54	53	55	−79
Krassnowodsk,	do.	15	do.	do.	40	0	52	59	−70
Fort Alexandrovsk,	do.	15	do.	do.	44	31	50	16	83
Gurgeu,	do.	15	do.	do.	47	7	51	55	−58
Astrachan,	do.	15	do.	do.	46	21	48	2	−68
Boasta,	do.	15	do.	do.	45	47	47	31	−85
Nukuss,	do.	15	do.	do.	42	27	59	37	216
Petro Alexandrovsk,	do.	15	do.	do.	41	28	61	5	326
Samarcand,	do.	15	do.	do.	39	39	66	57	2379
Margelan,	do.	15	do.	do.	40	28	71	43	2000
Taschkent,	do.	15	do.	do.	41	19	69	16	1516
Wernyj,	do.	15	do.	do.	43	16	76	53	2440
Karakol,	do.	2	1885–86	do.	42	30	77	26	5400
Semipalatinsk,	do.	15	1870–84	do.	50	24	80	13	794
Barnaul,	do.	15	do.	do.	53	20	83	47	459
Tomsk,	do.	15	do.	do.	56	30	84	58	254
Omsk,	do.	15	do.	do.	54	58	73	20	261
Ssalair,	do.	15	do.	do.	54	15	85	47	1115
Staro-Ssidorowa,	do.	15	do.	do.	55	26	65	10	322
Catharinenburg,	do.	15	do.	do.	56	49	60	38	894
Irbit,	do.	15	do.	do.	57	41	63	2	223
Bogoslowsk,	do.	15	do.	do.	59	45	60	1	636

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·570	29·552	29·470	29·455	29·380	29·321	29·244	29·333	29·444	29·565	29·573	29·528	29·453	–·030
29·414	29·411	29·311	29·282	29·241	29·169	29·135	29·198	29·318	29·440	29·448	29·390	29·313	–·030
29·762	29·758	29·656	29·604	29·543	29·420	29·360	29·475	29·596	29·760	29·777	29·755	29·627	–·030
29·828	29·816	29·737	29·650	29·595	29·472	29·402	29·510	29·635	29·788	29·824	29·812	29·672	+·020
29·662	29·690	29·544	29·528	29·454	29·426	29·375	29·430	29·564	29·678	29·662	29·643	29·555	+·020
29·851	29·860	29·705	29·666	29·583	29·552	29·512	29·579	29·693	29·819	29·827	29·792	29·701	...
30·091	30·087	29·965	29·870	29·815	29·740	29·681	29·776	29·906	30·083	30·091	30·067	29·931	–·020
29·966	29·954	29·824	29·765	29·724	29·671	29·624	29·690	29·820	29·938	29·930	29·875	29·816	...
29·017	30·001	29·880	29·820	29·810	29·780	29·693	29·752	29·839	29·957	29·968	29·917	29·870	...
29·945	29·906	29·784	29·723	29·723	29·687	29·664	29·706	29·794	29·875	29·849	29·829	29·790	...
30·09[illegible]	30·068	29·944	29·880	29·867	29·837	29·805	29·853	29·964	30·042	30·031	30·002	29·949	...
30·165	30·124	30·012	29·946	29·948	29·908	29·877	29·914	29·998	30·073	30·062	30·060	30·007	–·020
29·922	29·887	29·787	29·739	29·755	29·716	29·677	29·701	29·810	29·885	29·875	29·850	29·782	–·050
30·143	30·110	30·010	29·930	29·931	29·884	29·840	29·875	29·972	30·070	30·057	30·047	29·989	...
30·125	30·114	30·002	29·945	29·961	29·901	29·851	29·850	29·989	30·077	30·108	30·079	30·000	+·045
30·035	29·985	29·908	29·812	29·813	29·753	29·729	29·764	29·856	29·950	29·955	29·957	29·876	...
28·037	28·029	27·966	27·934	27·961	27·928	27·908	27·943	28·021	28·094	28·086	28·022	27·994	...
28·342	28·303	28·232	28·207	28·226	28·192	28·160	28·197	28·278	28·366	28·366	28·303	28·265	+·035
27·682	27·667	27·618	27·574	27·613	27·580	27·561	27·593	27·672	27·750	27·754	27·678	27·645	...
30·249	30·234	30·094	30·024	29·996	29·902	29·854	29·914	30·050	30·181	30·228	30·182	30·075	...
30·056	30·040	29·949	29·882	29·890	29·823	29·764	29·781	29·890	29·977	30·008	29·977	30·020	+·065
30·119	30·093	30·007	29·941	29·953	29·900	29·858	29·845	29·961	30·053	30·080	30·068	29·990	...
30·158	30·134	30·048	29·973	29·989	29·930	29·878	29·882	29·993	30·079	30·107	30·083	29·921	...
29·587	29·553	29·461	29·390	29·394	29·357	29·303	29·302	29·406	29·509	29·561	29·535	29·446	...
28·757	28·726	28·629	28·572	28·585	28·525	28·483	28·520	28·631	28·742	28·757	28·734	28·636	–·020
28·627	28·583	28·485	28·445	28·449	28·386	28·339	28·390	28·497	28·605	28·602	28·595	28·500	...
30·206	30·178	30·066	29·984	29·961	29·875	29·821	29·872	29·987	30·141	30·187	30·150	30·037	...
30·312	30·272	30·151	30·068	30·063	29·951	29·934	29·930	30·110	30·214	30·283	30·255	30·128	...
30·293	30·268	30·165	30·081	30·050	29·959	29·894	29·917	30·114	30·213	30·269	30·265	30·124	...
30·308	30·276	30·184	30·080	30·064	29·966	29·878	29·892	30·115	30·228	30·283	30·268	30·128	...
30·106	30·100	29·966	29·863	29·834	29·772	29·744	29·786	29·950	30·092	30·138	30·106	29·955	...
30·301	30·272	30·142	30·062	30·001	29·904	29·845	29·927	30·079	30·217	30·242	30·236	30·106	–·040
30·300	30·273	30·138	30·054	30·013	29·921	29·868	29·915	30·090	30·239	30·281	30·246	30·114	–·030
30·339	30·305	30·165	30·079	30·039	29·945	29·886	29·960	30·110	30·252	30·287	30·272	30·136	–·040
30·032	29·972	29·836	29·753	29·708	29·603	29·540	29·622	29·780	29·960	30·027	29·983	29·818	...
29·908	29·849	29·737	29·630	29·550	29·469	29·390	29·471	29·646	29·815	29·897	29·853	29·687	...
27·713	27·676	27·619	27·562	27·516	27·414	27·360	27·414	27·555	27·718	27·781	27·714	27·587	+·050
28·157	28·113	28·034	27·930	27·896	27·768	27·687	27·760	27·935	28·113	28·190	28·141	27·977	...
28·642	28·590	28·505	28·424	28·354	28·237	28·171	28·233	28·405	28·603	28·672	28·625	28·455	...
27·567	27·513	27·497	27·442	27·386	27·272	27·200	27·272	27·390	27·570	27·643	27·588	27·445	...
24·008	24·024	23·961	23·969	24·032	23·985	23·930	23·969	24·067	24·103	24·130	24·115	24·024	...
29·644	29·617	29·522	29·392	29·248	29·090	28·967	29·088	29·256	29·488	29·626	29·630	29·381	–·015
29·804	29·759	29·679	29·559	29·410	29·240	29·149	29·270	29·424	29·604	29·749	29·771	29·535	...
30·010	29·914	29·871	29·741	29·620	29·449	29·378	29·497	29·646	29·764	29·914	29·970	29·731	...
29·958	29·870	29·840	29·720	29·596	29·390	29·350	29·452	29·610	29·735	29·904	29·910	29·695	+·020
28·994	28·957	28·942	28·837	28·720	28·569	28·515	28·617	28·732	28·852	28·974	28·966	28·806	+·040
29·762	29·705	29·657	29·666	29·564	29·450	29·406	29·449	29·571	29·701	29·736	29·724	29·616	...
29·079	29·013	28·966	28·988	28·928	28·843	28·790	28·851	28·941	29·036	29·074	29·059	28·964	...
29·826	29·798	29·758	29·745	29·703	29·607	29·535	29·577	29·693	29·779	29·864	29·821	29·726	+·010
29·286	29·276	29·221	29·256	29·225	29·170	29·122	29·158	29·233	29·292	29·316	29·290	29·237	–·030

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Beresow,	Russia	15	1870–84	7 : 1, 9	63 56	65 4	120
Obdorsk,	do.	15	do.	do.	66 31	66 35	80
Turuchansk,	do.	$8\frac{1}{2}$	1877–85	do.	65 55	87 38	60
Enisseisk,	do.	15	1870–84	do.	58 27	92 6	275
Krassnojarsk,	do.	15	do.	do.	56 1	92 49	498
Urga,	do.	15	do.	do.	47 55	106 50	4300
Kjachta,	do.	15	do.	do.	50 29	106 35	2356
Wercholensk,	do.	15	do.	do.	54 8	105 30	1550
Irkutsk,	do.	15	do.	do.	52 16	104 16	1536
Olekminsk,	do.	15	do.	do.	60 22	120 26	400
Yakutsk,	do.	$1\frac{2}{3}$	?	?	62 2	129 14	334
Werkojansk,	do.	3	1883–86	7 : 1, 9	67 34	133 51	460
Mouth of the Lena,	do.	1	1882–83	do.	74 48	126 45	16
Anadyr,	do.	$\frac{3}{4}$	1866–67	6, N.: 6	64 55	177 19	20
Petropaulovsk,	do.	5	1828, 1846, 1848–50	M.P.	53 0	159 39	50
Behring Is.,	do.	4	1882–86	: 11	55 12	165 55	20
P. Okhotsk,	do.	$7\frac{2}{3}$	1843–50	M.P.	59 20	142 40	12
P. Ayan,	do.	3	1847–50	7 : 2, 9	56 27	138 11	45
Udsk Vill,	do.	$\frac{5}{12}$	1829–30	?	54 29	134 37	35
Nertschinsk,	do.	15	1870–84	7 : 1, 9	51 19	119 37	2080
Blagoweschtschensk,	do.	15	do.	do.	50 15	127 38	361
Chabarowka,	do.	15	do.	do.	48 26	135 7	60
Alexandrowka,	do.	15	do.	do.	50 50	142 7	53
Nikolaewsk,	do.	15	do.	do.	53 8	140 45	60
Due,	do.	2	1874, 1875	do.	50 50	142 7	330
Kusunai,	do.	$\frac{2}{3}$	1867–68	?	47 49	142 20	10
St. Olga,	do.	9	1876–84	do.	43 44	135 20	149
Wladiwostock,	do.	9	do.	do.	43 7	131 54	57
Askold,	do.	9	do.	do.	42 44	132 21	84
Nemuro,	Japan	6	1881–86	6 : 2, 10	43 20	145 31	43
Sapporo,	do.	6	do.	do.	43 4	141 23	60
Hakodate,	do.	6	do.	do.	41 46	140 44	10
Hakodate,	do.	$4\frac{1}{3}$	1859–63	do.	41 47	140 45	150
Aomori,	do.	6	1881–86	do.	40 51	140 45	33
Akita,	do.	6	do.	do.	39 42	140 7	33
Miyako,	do.	6	do.	do.	39 38	141 59	100
Nobiru,	do.	6	do.	do.	38 23	141 12	15
Niigata,	do.	6	do.	do.	37 55	139 3	32
Kanazawa,	do.	6	do.	do.	36 33	136 40	95
Tokio,	do.	6	do.	do.	35 41	139 45	69
Do.	do.	17	1870–86	do.	35 41	139 45	69
Numazu,	do.	6	1881–86	do.	35 6	138 51	30
Hamamatsu,	do.	6	do.	do.	34 42	137 43	92
Gifu,	do.	6	do.	do.	35 27	136 46	49
Kioto,	do.	6	do.	do.	35 1	135 46	162
Wakayama,	do.	6	do.	do.	34 14	135 9	49
Osaka,	do.	6	do.	do.	34 42	135 30	13
Sakai,	do.	6	do.	do.	35 33	133 13	7
Hiroshima,	do.	6	do.	do.	34 23	132 27	15
Kochi,	do.	6	do.	do.	33 33	133 34	20

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·882	29·831	29·729	29·875	29·804	29·776	29·642	29·670	29·725	29·760	29·784	29·780	29·772	...
29·882	29·835	29·741	29·878	29·831	29·804	29·697	29·745	29·733	29·741	29·772	29·756	29·785	...
30·119	30·020	29·993	30·020	29·886	29·756	29·717	29·788	29·851	29·898	30·048	30·213	29·942	...
30·025	29·940	29·852	29·707	29·605	29·467	29·394	29·519	29·657	29·764	29·900	30·008	29·737	−·040
29·796	29·724	29·676	29·493	29·355	29·207	29·154	29·266	29·422	29·552	29·715	29·776	29·511	...
25·682	25·682	25·597	25·501	25·434	25·418	25·410	25·520	25·544	25·725	25·689	29·658	25·569	...
27·717	27·686	27·646	27·473	27·394	27·308	27·249	27·347	27·457	27·583	27·654	27·697	27·518	...
28·595	28·193	28·126	28·284	28·158	28·058	28·006	28·103	28·254	28·410	28·506	28·587	28·323	...
28·596	28·546	28·486	28·329	28·226	28·103	28·044	28·165	28·331	28·444	28·530	28·580	28·365	−·140
29·823	29·800	29·710	29·492	29·327	29·213	29·170	29·272	29·484	29·540	29·646	29·721	29·519	...
29·895	29·957	29·748	29·620	29·472	29·366	29·383	29·435	29·711	29·670	29·829	30·060	29·679	...
29·585	29·694	29·532	29·351	29·193	29·067	29·138	29·217	29·323	29·356	29·469	29·458	29·365	...
29·980	30·115	30·077	30·150	29·750	29·620	29·835	29·782	29·682	29·896	29·874	29·988	29·896	...
30·143	30·089	29·883	29·972	29·917	29·928	...	...	...	29·806	29·879	29·927	...	...
295·19	29·632	29·774	29·773	29·701	29·651	29·693	29·810	29·803	29·723	29·624	29·539	29·687	...
29·470	29·820	29·773	29·745	29·762	29·783	29·790	29·808	29·857	29·673	29·673	29·562	29·726	...
29·854	29·923	29·902	29·846	29·799	29·772	29·725	29·796	29·850	29·816	29·760	29·710	29·813	...
29·845	29·957	29·896	29·853	29·753	29·764	29·661	29·795	29·839	29·891	29·823	29·824	29·825	...
29·540	29·460	29·600	...	...	...	...	...	...	...	29 570	29·500	...	...
27·954	27·952	27·835	27·683	27·590	27·558	27·567	27·632	27·769	27·846	27·859	27·904	27·762	...
29·838	29·821	29·706	29·530	29·396	29·398	29·360	29·447	29·608	29·701	29·764	29·821	29·616	...
30·125	30·118	30·004	29·876	29·766	29·763	29·727	29·816	29·930	30·044	30·075	30·076	29·943	...
29·905	29·944	29·890	29·850	29·802	29·810	29·738	29·745	29·846	29·860	29·890	29·831	29·843	...
29·843	29·873	29·870	29·798	29·748	29·725	29·664	29·676	29·799	29·806	29·849	29·814	29·789	...
29·530	29·480	29·440	29·360	29·370	29·380	29·370	29·380	29·460	29·500	29·410	29·480	29·430	...
29·696	29·996	29·977	29·840	29·903	29·770	...	...	...	...	29·823	30·007	...	...
29·926	29·923	29·847	29·801	29·705	29·690	29·670	29·712	29·822	29·851	29·898	29·890	29·813	...
30·142	30·144	29·988	29·896	29·755	29·734	29·698	29·739	29·890	30·000	30·040	30·073	29·926	...
30·070	30·088	29·938	29·872	29·723	29·740	29·680	29·714	29·840	29·950	30·000	30·023	29·885	...
29·786	29·858	29·878	29·915	29·823	29·793	29·800	29·826	29·933	29·950	29·881	29·815	29·855	...
29·836	29·918	29·892	29·888	29·777	29·747	29·756	29·780	29·868	29·952	29·900	29·862	29·848	...
29·919	30·000	29·966	29·967	29·860	29·832	29·841	29·856	29·938	30·026	29·966	29·929	29·925	...
29·909	29·954	30·032	29·986	29·908	29·801	29·797	29·820	29·928	30·036	30·032	29·935	29·926	...
29·924	30·002	29·964	29·950	29·832	29·806	29·810	29·831	29·909	30·008	29·974	29·934	29·913	...
29·976	30·034	30·000	29·986	29·866	29·810	29·813	29·840	29·903	30·023	30·000	29·980	29·936	...
29·846	29·900	29·893	29·888	29·797	29·750	29·761	29·787	29·866	29·950	29·907	29·866	29·851	...
29·969	30·028	30·006	29·997	29·891	29·836	29·832	29·865	29·940	30·033	30·002	29·978	29·948	...
30·008	30·049	30·035	29·988	29·880	29·813	29·812	29·830	29·907	30·023	30·021	30·019	29·949	...
30·000	30·036	29·989	29·926	29·823	29·753	29·757	29·776	29·855	29·973	29·997	30·000	29·907	...
30·010	30·050	30·014	30·009	29·915	29·855	29·865	29·897	29·956	30·054	30·046	30·032	29·975	...
30·014	30·054	30·023	30·014	29·929	29·861	29·850	29·878	29·942	30·057	30·062	30·024	29·977	...
29·959	29·983	29·975	29·967	29·892	29·837	29·841	29·869	29·920	30·010	29·995	29·987	29·936	...
29·951	29·959	29·943	29·916	29·829	29·778	29·782	29·802	29·857	29·920	29·943	29·963	29·887	...
30·008	30·056	29·989	29·961	29·859	29·808	29·808	29·827	29·886	29·977	30·016	30·032	29·936	...
29·950	29·953	29·906	29·855	29·741	29·682	29·686	29·706	29·764	29·878	29·930	29·961	29·834	...
30·071	30·087	30·032	29·961	29·863	29·788	29·800	29·808	29·875	29·985	30·052	30·087	29·951	...
30·101	30·126	30·059	29·998	29·890	29·820	29·830	29·850	29·918	30·032	30·106	30·120	29·987	...
30·118	30·152	30·093	30·006	29·902	29·826	29·835	29·847	29·934	30·056	30·108	30·122	30·000	...
30·142	30·162	30·088	30·000	29·886	29·812	29·816	29·839	29·898	30·040	30·115	30·154	29·996	...
30·100	30·111	30·072	29·992	29·902	29·840	29·850	29·962	29·922	30·012	30·087	30·129	29·980	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Shimonoseki,	Japan	6	1881–86	6 : 2, 10	33 58	130 57	135
Miyasaki,	do.	6	do.	do.	31 56	131 26	26
Kagoshima,	do.	6	do.	do.	31 35	130 33	13
Nagasaki,	do.	6	do.	do.	32 44	129 52	190
Nagasaki,	do.	15	1871–85	various	32 44	129 52	various
Nafa,	Pelew	2	1856–58	6 : 1, 10	26 13	128 44	33
Fusan,	Corea	2½	1884–86	6 : 2, 10	35 6	129 2	32
Newchwang,	do.	1	1861–62	daybreak 2–4	40 57	121 27	[0]
Sung-shu-chwang,	China	1	1882–83	: 7	36 7	103 36	4870
Pekin,	do.	15	1870–84	7 : 1, 9	39 57	116 28	123
Tien-Tsin,	do.	2½	1860–61, 1871–72	9 : 3	39 9	117 16	29
Tchang-kia-tchouang	do.	¾	1882–83	: 8	38 17	116 14	98
Hankow,	do.	5	1877–81	M.P.	30 32	114 19	260
Wuhu,	do.	1	1881	do.	31 21	118 21	35
Kiu-kiang,	do.	4	1878–81	do.	29 44	116 8	180
Yarkand,	do.	1	1874–75	do.	38 25	77 16	4124
Zi-ki-Wei,	do.	14	1873–86	do.	31 12	121 20	23
Shanghai,	do.	2	1867–68	various	30 4	121 27	0
Foochow,	do.	1½	1886–87	: 8	26 8	119 38	34
Kelung,	do.	2	1867–68	7 : 1, 9	25 20	121 46	49
South Cape,	do.	1½	1886–87	: 8	21 55	120 51	121
Canton,	do.	10	?	?	23 12	113 17	100
Hong Kong,	do.	15	1870–84	9 : 3	22 18	114 10	35
Hong Kong,	do.	4	1884–87	10 : 4	22 18	114 10	110
Victoria Peak,	do.	4	do.	do.	22 0	114 0	1816
Macao,	do.	15	1870–84	M.P.	22 11	113 32	26
Hanoi,	Annam	⅓	1883	do.	21 1	105 48	45
Hué,	do.	6	1881–86	do.	16 33	107 38	20
Saigon,	Cochin China	6	1874–79	do.	10 47	106 42	[0]
Bankok,	Siam	6	1863–68	do.	13 38	100 27	[0]
Singapore,	Malay Peninsula	5	1841–45	hourly	1 15	103 51	24
Do.	do.	9	1841-45,77,81,85-86	9 : 3	1 15	103 51	18
Raffles Light,	do.	2	1866–67	Noon	1 9	103 44	65
Penang,	do.	2	1885–86	9 : 3	5 24	100 20	20
Wellesley,	do.	2	do.	do.	5 22	100 30	43
Malacca,	do.	2	do.	do.	2 10	102 14	12
Kwala Lumpor,	do.	1	1884	do.	3 10	101 50	177
Tuguegaras,	Phillipine Islands	2	1881–82	: 8	17 37	121 30	125
Manila,	do.	22	1865–86	M.P.	14 35	120 59	54
Moresby Bay,	New Guinea	1	1875–76	9 :	−9 32	146 10	278
Hatzfeldthafen,	do.	1	1886–87	7 : 2, 9	−4 24	145 14	7
Buitenzorg,	East Indies	12	1841–54	6, 9 : 3, 10	−6 37	106 49	889
Batavia,	do.	15	1870–84	hourly	−6 11	106 50	23
Padang,	do.	3½	1850–53	6, 9 : 3, 10	−0 56	100 2	240
Nancowry,	India	15	1870–84		8 0	93 46	81
Port Blair,	do.	15	do.	M.P.*	11 41	92 42	61
Mergui,	do.	15	do.	do.	12 11	98 38	96
Moulmein,	do.	15	do.	do.	16 29	97 40	94
Rangoon,	do.	15	do.	do.	16 46	96 12	41
Diamond Island,	do.	15	do.	do.	15 52	94 19	41

* Indian Stations at 10 : 4, or 4, 10 : 4, 10, from which Mean Pressure is deduced.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·024	30·046	29·975	29·882	29·780	29·697	29·701	29·707	29·800	29·930	30·006	30·050	29·882	...
30·138	30·143	30·077	29·995	29·902	29·837	29·841	29·837	29·894	30·014	30·118	30·164	29·997	...
30·176	30·178	30·103	30·006	29·920	29·850	29·847	29·842	29·902	30·028	30·134	30·197	30·015	...
29·988	29·992	29·914	29·812	29·717	29·642	29·646	29·630	29·713	29·851	29·953	30·016	29·823	...
30·219	30·178	30·114	30·033	29·906	29·841	29·838	29·832	29·908	30·066	30·156	30·178	30·022	...
30·087	30·080	30·063	29·991	29·868	29·802	29·780	29·677	29·783	29·918	30·065	30·115	29·935	...
30·191	30·195	30·108	30·018	29·886	29·786	29·788	29·780	29·871	30·065	30·118	30·179	29·999	−·030
30·361	30·247	30·172	29·912	29·897	29·727	29·727	29·830	30·074	30·168	30·152	30·255	29·043	−·100
25·440	25·370	25·330	25·100	25·170	25(·080)	25·040	25·120	25·250	25·360	25·330	25·370	25·238	...
30·265	30·197	30·032	29·835	29·669	29·573	29·521	29·618	29·834	30·008	30·150	30·202	29·905	...
30·356	30·360	30·098	29·980	29·845	29·696	29·564	29·691	29·918	30·092	30·166	30·262	30·005	...
30·300	30·300	30·080	29·890	29·750	29·670	...	...	...	30·010	30·280	30·320	...	...
30·395	30·297	30·242	30·053	29·903	29·808	29·749	29·785	29·986	30·206	30·293	30·395	30·091	−·070
30·260	30·213	30·316	29·941	29·934	29·753	29·682	29·720	29·934	30·079	30·193	30·359	30·032	...
30·272	30·175	30·107	29·910	29·678	29·552	29·453	29·512	29·686	29·941	30·091	30·221	29·883	...
26·201	25·973	25·874	25·890	25·813	25·737	25·646	(25·756)	(25·965)	(26·138)	26·182	26·091	25·934	...
30·349	30·288	30·184	30·008	29·868	29·758	29·695	29·732	29·905	30·113	30·252	30·304	30·038	...
30·254	30·186	30·108	29·914	29·848	29·707	29·719	29·729	29·903	30·062	30·211	30·205	29·990	...
30·220	30·220	(30·086)	29·940	29·850	29·690	29·710	29·700	29·895	30·070	30·250	30·210	29·987	...
30·255	30·216	30·161	30·003	29·910	29·814	29·728	29·728	29·818	29·988	30·173	30·204	30·000	...
29·920	29·940	(29·920)	29·830	29·740	29·680	29·660	29·685	29·685	29·830	29·945	29·990	29·819	...
30·175	30·099	30·018	29·819	29·761	29·731	29·656	29·659	29·685	29·912	30·071	30·123	29·895	...
30·200	30·157	30·087	29·977	29·868	29·804	29·751	29·796	29·854	30·007	30·120	30·177	29·983	...
30·054	30·017	29·952	29·855	29·774	29·666	29·613	29·643	29·708	29·900	30·020	30·074	29·859	...
28·263	28·240	28·175	28·120	28·065	27·980	27·933	27·960	28·014	28·177	28·264	28·288	28·010	...
30·197	30·146	30·097	29·990	29·865	29·796	29·737	29·755	29·857	29·997	30·120	30·189	29·979	...
...	...	...	...	...	...	...	29·728	29·858	30·029	30·043	...	...	...
30·057	30·038	29·943	29·958	29·849	29·806	29·800	29·815	29·892	29·990	30·053	30·132	29·944	+·100
29·989	29·977	29·973	29·930	29·914	29·902	29·882	29·902	29·902	29·977	29·938	29·993	29·942	...
29·984	29·938	29·906	29·855	29·812	29·792	29·800	29·804	29·808	29·878	29·977	30·004	29·878	...
29·916	29·913	29·882	29·884	29·853	29·857	29·868	29·880	29·891	29·897	29·874	29·890	29·884	...
29·916	29·907	29·888	29·866	29·850	29·853	29·867	29·877	29·887	29·887	29·871	29·878	29·879	...
29·911	29·933	29·930	29·865	29·906	29·935	29·913	29·920	29·912	29·912	29·924	29·894	29·915	...
29·900	29·904	29·893	29·870	29·859	29·852	29·865	29·869	29·860	29·904	29·900	29·890	29·878	+·040
29·902	29·878	29·856	29·838	29·854	29·851	29·860	29·853	29·864	29·866	29·882	29·890	29·865	+·040
29·907	29·902	29·877	29·865	29·868	29·864	29·871	29·879	29·887	29·881	29·889	29·902	29·883	+·040
29·736	29·729	29·719	29·694	29·700	29·712	29·706	29·708	29·716	29·740	29.828	29·723	29·718	−·110
29·940	29·975	29·920	29·825	29·775	29·740	29·675	29·690	29·715	29·725	29·760	29·880	29·810	...
29·983	29·987	29·975	29·944	29·900	29·877	29·861	29·841	29·837	29·885	29·908	29·957	29·913	...
29·976	29·992	30·025	30·038	30·054	30·072	30·080	30·122	30·164	...	...	...	...	...
29·881	29·826	29·893	29·913	29·909	29·913	29·928	29·905	29·948	29·960	29·921	29·878	29·906	+·050
28·973	29·004	28·993	28·980	28·970	28·966	28·960	28·973	28·981	28·985	28·963	28·926	28·973	...
29·862	29·869	29·867	29·847	29·848	29·870	29·882	29·885	29·892	29·877	29·861	29·852	29·867	...
29·686	29·696	29·696	29·662	29·646	29·662	29·670	29·689	29·698	29·704	29·666	29·691	29·680	...
29·845	29·856	29·842	29·794	29·758	29·765	29·767	29·776	29·800	29·804	29·820	29·829	29·805	...
29·893	29·889	29·864	29·801	29·746	29·729	29·732	29·748	29·777	29·802	29·836	29·873	29·808	...
29·862	29·860	29·827	29·777	29·742	29·741	29·735	29·750	29·775	29·790	29·821	29·850	29·794	...
29·877	29·840	29·806	29·745	29·692	29·686	29·683	29·694	29·720	29·757	29·810	29·859	29·764	...
29·947	29·908	29·858	29·794	29·740	29·727	29·725	29·746	29·782	29·830	29·895	29·938	29·824	...
29·964	29·934	29·895	29·830	29·764	29·730	29·726	29·751	29·782	29·839	29·900	29·950	29·839	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	Latitude. '	Longtitude. °	Longtitude. '	Height, Feet.
Bassein, . .	India	15	1870–84	M.P.	16	47	94	50	35
Toungoo, . .	do.	15	do.	do.	18	57	96	24	169
Thayetmyo, . .	do.	15	do.	do.	19	22	95	12	134
Akyab, . .	do.	15	do.	do.	20	28	92	57	20
Chittagong, . .	do.	15	do.	do.	22	21	91	50	87
Dacca, . . .	do.	15	do.	do.	23	43	90	27	35
Silchar, . .	do.	15	do.	do.	24	49	92	50	104
Sibsagar, . .	do.	15	do.	do.	26	59	94	40	333
Goalpara, . .	do.	15	do.	do.	26	11	90	40	395
Darjeeling, . .	do.	15	do.	do.	27	3	88	18	7421
Purneah, . .	do.	15	do.	do.	25	50	87	34	125
Patna, . . .	do.	15	do.	do.	25	37	85	14	183
Gorakhpur, . .	do.	15	do.	do.	26	46	83	18	256
Benares, . .	do.	15	do.	do.	25	20	83	2	267
Allahabad, . .	do.	15	do.	do.	25	26	81	52	307
Lucknow, . .	do.	15	do.	do.	26	50	81	0	369
Bareilly, . .	do.	15	do.	do.	28	21	79	27	568
Meerut, . .	do.	15	do.	do.	29	0	77	41	737
Ranikhet, . .	do.	15	do.	do.	29	38	79	29	6069
Roorkee, . .	do.	15	do.	do.	29	52	77	56	887
Chakrata, . .	do.	15	do.	do.	30	40	77	55	7052
Delhi, . . .	do.	15	do.	do.	28	40	77	16	718
Sirsa, . . .	do.	15	do.	do.	29	32	75	6	662
Bikaneer, . .	do.	15	do.	do.	27	59	73	14	744
Ajmere, . .	do.	15	do.	do.	26	28	74	37	1611
Jeypore, . .	do.	15	do.	do.	26	55	75	50	1431
Agra, . . .	do.	15	do.	do.	27	10	78	5	555
Jhansi, . . .	do.	15	do.	do.	25	27	78	37	855
Saugor, . .	do.	15	do.	do.	23	49	78	48	1769
Gya, . . .	do.	15	do.	do.	24	42	85	2	375
Hazaribagh, . .	do.	15	do.	do.	24	0	85	24	2007
Berhampore, .	do.	15	do.	do.	24	6	88	17	66
Burdwan, . .	do.	15	do.	do.	23	14	87	54	99
Calcutta, . .	do.	15	do.	do.	22	32	88	20	21
Saugor Island, .	do.	15	do.	do.	21	39	88	5	25
False Point, .	do.	15	do.	do.	20	20	86	47	21
Cuttack, . .	do.	15	do.	do.	20	29	85	54	80
Sambalpur, . .	do.	15	do.	do.	21	31	84	1	463
Raipur, . .	do.	15	do.	do.	21	15	81	41	960
Nagpur, . .	do.	15	do.	do.	21	9	79	11	1025
Akola, . .	do	15	do.	do.	20	42	77	4	930
Chanda, . .	do	15	do.	do.	19	56	79	19	652
Sironcha, . .	do	15	do.	do.	18	51	80	0	401
Vizagapatam, .	do.	15	do.	do.	17	42	83	22	31
Masulipatam, .	do.	15	do.	do.	16	9	81	12	10
Secunderabad, .	do.	15	do.	do.	17	27	78	33	1787
Sholapur, . .	do.	15	do.	do.	17	41	75	56	1590
Bellary, . .	do.	15	do.	do.	15	9	76	57	1455
Bangalore, . .	do.	15	do.	do.	12	59	77	38	2981
Madras, . .	do.	15	do.	do.	13	4	80	14	22

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·967	29·918	29·875	29·813	29·758	29·731	29·725	29·745	29·782	29·838	29·900	29·954	29·834	...
29·821	29·758	29·687	29·629	29·580	29·566	29·557	29·577	29·623	29·695	29·764	29·810	29·672	...
29·842	29·780	29·723	29·641	29·598	29·575	29·567	29·591	29·640	29·718	29·800	29·853	29·694	...
29·998	29·956	29·904	29·830	29·757	29·676	29·665	29·706	29·761	29·848	29·932	29·991	29·835	...
29·937	29·897	29·823	29·745	29·666	29·566	29·556	29·603	29·677	29·783	29·873	29·935	29·755	...
29·997	29·944	29·848	29·758	29·685	29·575	29·562	29·622	29·707	29·827	29·936	29·000	29·788	...
29·935	29·888	29·807	29·727	29·648	29·540	29·529	29·579	29·657	29·777	29·878	29·938	29·742	...
29·730	29·664	29·586	29·502	29·419	29·298	29·280	29·230	29·422	29·558	29·671	29·735	29·516	...
29·632	29·570	29·475	29·397	29·324	29·215	29·194	29·255	29·342	29·476	29·584	29·643	29·426	...
22·964	22·939	22·943	22·942	22·915	22·862	22·859	22·898	22·955	23·018	23·034	23·007	22·945	...
29·902	29·837	29·727	29·624	29·549	29·439	29·444	29·491	29·582	29·731	29·841	29·905	29·672	...
29·867	29·800	29·677	29·556	29·467	29·348	29·356	29·422	29·512	29·683	29·810	29·883	29·615	...
29·773	29·706	29·591	29·465	29·374	29·258	29·265	29·330	29·422	29·599	29·730	29·795	29·526	...
29·773	29·713	29·601	29·471	29·363	29·251	29·256	29·321	29·416	29·596	29·725	29·785	29·523	...
29·734	29·670	29·555	29·432	29·319	29·202	29·215	29·278	29·372	29·553	29·683	29·752	29·480	...
29·669	29·606	29·500	29·370	29·260	29·146	29·152	29·220	29·317	29·488	29·623	29·688	29·420	...
29·417	29·382	29·282	29·156	29·056	28·938	28·946	29·010	29·108	29·275	29·403	29·470	29·206	...
29·284	29·224	29·124	28·990	28·875	28·748	28·761	28·828	28·929	29·104	29·232	29·285	29·032	...
24·110	24·084	24·085	24·061	24·013	23·935	23·934	23·961	24·031	24·106	24·150	24·140	24·051	...
29·114	29·062	28·960	28·849	28·739	28·617	28·629	28·695	28·798	28·964	29·087	29·140	28·888	...
23·259	23·222	23·247	23·239	23·196	23·132	23·114	23·154	23·229	23·295	23·315	23·300	23·225	...
29·312	29·254	29·154	29·023	28·906	28·780	28·786	28·854	28·964	29·140	29·274	29·332	29·065	...
29·380	29·322	29·221	29·082	28·958	28·831	28·830	28·896	29·020	29·193	29·333	29·392	29·122	...
29·291	29·229	29·119	28·996	28·862	28·749	28·733	28·810	28·926	29·105	29·238	29·298	29·030	...
28·408	28·364	28·280	28·186	28·074	27·985	27·955	28·026	28·112	28·288	28·400	28·438	28·202	...
28·576	28·530	28·440	28·345	28·238	28·123	28·113	28·195	28·280	28·446	28·556	28·603	28·370	...
29·483	29·426	29·324	29·194	29·071	28·963	28·963	29·036	29·136	29·310	29·444	29·507	29·238	...
29·158	29·118	29·020	28·897	28·776	28·674	28·668	28·736	28·832	29·002	29·120	29·169	28·931	...
28·233	28·183	28·110	(28·002)	27·906	27·813	27·798	27·860	27·941	28·108	28·202	28·238	28·032	...
29·677	29·601	29·498	29·380	29·280	29·165	29·182	29·240	29·331	29·500	29·629	29·689	29·431	...
27·978	27·936	27·865	27·774	27·680	27·571	27·568	27·627	27·708	27·866	27·960	27·995	27·794	...
29·963	29·902	29·789	29·670	29·605	29·489	29·486	29·553	29·642	29·799	29·911	29·970	29·732	...
29·933	29·873	29·759	29·645	29·570	29·468	29·447	29·507	29·608	29·765	29·881	29·943	29·700	...
30·018	29·960	29·858	29·760	29·672	29·559	29·548	29·613	29·702	29·841	29·958	30·027	29·793	...
30·005	29·952	29·855	29·760	29·670	29·553	29·538	29·600	29·687	29·831	29·948	30·016	29·785	...
30·024	29·973	29·878	29·778	29·686	29·587	29·567	29·623	29·700	29·843	29·974	30·041	29·806	...
29·951	29·893	29·798	29·696	29·602	29·500	29·498	29·554	29·632	29·777	29·901	29·966	29·731	...
29·562	29·494	29·396	29·267	29·165	29·068	29·095	29·176	29·217	29·372	29·498	29·567	29·323	...
29·034	28·987	28·890	28·782	28·680	28·587	28·590	28·684	28·716	28·882	29·003	29·048	28·824	...
28·964	28·912	28·826	28·723	28·632	28·556	28·560	28·645	28·667	28·822	28·938	28.984	28·769	...
29·057	29·010	28·936	28·838	28·756	28·678	28·686	28·741	28·797	28·931	29·033	29·082	28·879	...
29·366	29·306	29·216	29·115	29·021	28·960	28·979	29·025	29·079	29·220	29·334	29·390	29·167	...
29·624	29·586	29·493	29·395	29·302	29·253	29·288	29·301	29·348	29·470	29·581	29·638	29·440	...
29·996	29·951	29·878	29·787	29·683	29·593	29·591	29·633	29·692	29·813	29·931	29·996	29·795	...
30·009	29·971	29·904	29·814	29·706	29·656	29·674	29·699	29·742	29·839	29·945	30·005	29·830	...
28·183	28·154	28·099	28·024	27·950	27·911	27·911	27·942	27·980	28·071	28·145	28·194	28·047	...
28·387	28·351	28·291	28·203	28·148	28·109	28·115	28·148	28·193	28·272	28·346	28·397	28·247	...
28·499	28·460	28·406	28·335	28·290	28·277	28·293	28·310	28·340	28·397	28·460	28·501	28·381	...
28·009	27·993	27·961	27·906	27·862	27·847	27·855	27·869	27·896	27·926	27·968	28·005	27·925	...
29·987	29·965	29·905	29·813	29·717	29·692	29·714	29·742	29·765	29·836	29·913	29·978	29·836	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Samsoun,	Syria	15	1870–84	: 3, 9	41	18	36	19	26
Scutari,	do.	15	do.	9 : 3	41	0	29	3	60
Smyrna (not red. to 32°),	do.	6½	1864–70	Noon	38	26	27	10	25
Cyprus,	do.	7	1866–70, 81–82, 87	9 : 9	34	55	33	37	25
Papho,	do.	2½	1881–82, 87	do.	34	46	32	25	227
Red Sea,*	...	...	...	...	29	0	33	0	[0]
Do.	...	...	...	...	27	0	34	20	[0]
Do.	...	...	...	...	25	0	35	40	[0]
Do.	...	...	...	...	23	0	37	0	[0]
Do.	...	...	...	...	21	0	38	10	[0]
Do.	...	...	...	...	19	0	39	30	[0]
Do.	...	...	...	...	17	0	40	40	[0]
Do.	...	...	...	...	15	0	42	0	[0]
Do.	...	...	...	...	13	0	43	10	[0]
Do.	...	...	...	...	12	40	45	0	[0]
Do.	...	...	...	...	12	45	47	0	[0]
Do.	...	...	...	...	12	50	49	0	[0]
Assab,	Africa	1	1882	9 : 3	12	59	42	45	41
Massuah,	do.	⅔	1831–32	9 : 3½	15	36	39	20	5
Condar,	do.	1$\frac{7}{12}$	1832–33	9 : 3	15	50	37	32	7422
Kosseir,	do.	1	1872–73	M.P.	26	5	34	16	[0]
Suez,	do.	5½	1880–85	8 : 2	29	59	32	31	24
Ismailia,	do.	5½	do.	7 : 2¼, 6	30	36	32	16	29
Said,	do.	5½	do.	7 : 2¼, 5	31	16	32	18	20
Alexandria,	do.	15	1870–84	9 : 3	31	12	29	53	62
Cairo,	do.	15	do.	three-hourly	30	5	31	17	108
Bengasi,	do.	1	1882	9 : 3	32	7	20	3	33
Tripoli,	Tripoli	4½	1879–84	N. : 6	32	53	13	11	98
Tunis,	Tunis	15	1870–84	: 1	36	42	10	13	46
Le Calle,	Algeria	15	do.	7 : 1, 7	36	54	8	26	35
Guelma,	do.	15	do.	do.	36	28	7	27	917
Constantine,	do.	15	do.	do.	36	22	6	36	2165
Bougie,	do.	15	do.	do.	36	47	5	5	219
Algiers,	do.	15	do.	do.	36	47	3	4	73
Orléansville,	do.	15	do.	do.	36	10	1	21	387
Oran,	do.	15	do.	do.	35	42	—0	39	173
Cape Falcon,	do.	15	do.	do.	35	46	—0	47	257
Nemours,	do.	15	do.	do.	35	6	—1	51	13
Tébessa,	do.	15	do.	do.	35	24	8	6	2890
Aumale,	do.	15	do.	do.	36	10	3	41	2972
Biskra,	do.	15	do.	do.	34	5	5	40	409
Laghouat,	do.	15	do.	do.	33	48	2	51	2454
Tlemsen,	do.	15	do.	do.	34	53	—1	18	2703
Sidi-Bel-Abbés,	do.	15	do.	do.	35	2	—0	39	1562
Ghadames,	Sahara	⅙	1865	9 : 3	30	9	9	3	1323

* The small figures in brackets show the number of observations, from ships' logs, from which the means have been deduced. For these Red Sea means the author is indebted to the courtesy of the Meteorological Council.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·115	30·100	29·997	29·926	29·950	29·898	29·860	29·890	29·985	30·057	30·071	30·044	29·991	...
30·096	30·083	29·956	29·904	29·915	29·884	29·858	29·870	29·980	30·024	30·016	30·017	29·966	...
30·024	30·008	29·798	29·917	29·888	29·830	29·732	29·727	29·878	29·856	29·987	29·992	29·895	...
30·098	30·077	29·953	29·916	29·918	29·878	29·754	29·816	29·907	30·033	30·062	30·047	29·955	...
30·084	30·053	30·024	29·911	29·933	29·880	29·751	29·784	29·908	30·027	30·053	30·083	29·958	
30·105	30·063	29·978	29·904	29·892	29·837	29·779	29·767	29·862	29·930	30·018	30·059	29·940	...
[154]	[196]	[253]	[205]	[231]	[212]	[237]	[163]	[182]	[215]	[232]	[212]		
30·093	30·038	29·941	29·981	29·846	29·777	29·726	29·712	29·815	29·911	29·988	30·028	29·905	...
[149]	[208]	[253]	[237]	[265]	[240]	[198]	[174]	[177]	[218]	[245]	[210]		
30·075	30·020	29·948	29·861	29·839	29·759	29·726	29·710	29·795	29·894	29·972	30·020	29·885	...
[147]	[194]	[225]	[210]	[235]	[216]	[195]	[152]	[168]	[210]	[252]	[203]		
30·039	29·998	29·933	29·859	29·824	29·741	29·727	29·698	29·764	29·897	29·950	30·001	29·869	...
[150]	[191]	[224]	[235]	[214]	[215]	[180]	[143]	[174]	[200]	[231]	[191]		
30·013	29·974	29·908	29·847	29·805	29·735	29·721	29·699	29·754	29·891	29·942	29·984	29·856	...
[150]	[191]	[229]	[243]	[203]	[222]	[196]	[143]	[167]	[194]	[251]	[222]		
29·985	29·960	29·894	29·838	29·807	29·735	29·708	29·699	29·753	29·881	29·927	29·965	29·846	...
[147]	[193]	[243]	[208]	[223]	[191]	[185]	[146]	[175]	[177]	[285]	[241]		
29·972	29·944	29·889	29·854	29·807	29·728	29·703	29·708	29·769	29·879	29·941	29·979	29·848	...
[147]	[210]	[331]	[220]	[199]	[181]	[189]	[141]	[193]	[193]	[235]	[234]		
29·982	29·930	29·881	29·829	29·793	29·729	29·701	29·701	29·766	29·876	29·943	29·986	29·843	...
[231]	[223]	[343]	[362]	[223]	[200]	[190]	[145]	[192	[185]	[282]	[258]		
30·017	29·958	29·902	29·841	29·809	29·715	29·687	29·707	29·760	29·892	29·970	30·010	29·856	...
[137]	[190]	[231]	[217]	[208]	[172]	[156]	[117]	[166]	[156]	[213]	[246]		
30·053	30·007	29·927	29·866	29·800	29·706	29·652	29·699	29·776	29·917	29·993	30·038	29·870	...
[189]	[193]	[310]	[218]	[252]	[192]	[183]	[170]	[210]	[161]	[189]	[283]		
30·047	30·006	29·944	29·897	29·815	29·713	29·660	29·696	29·776	29·919	30·008	30·042	29·877	...
[153]	[191]	[259]	[187]	[220]	[162]	[169]	[138]	[184]	[187]	[189]	[206]		
30·062	30·019	29·956	29·894	29·818	29·723	29·669	29·710	29·778	29·932	30·004	30·044	29·884	...
[162]	[198]	[262]	[165]	[238]	[167]	[168]	[157]	[177]	[156]	[195]	[203]		
29·958	29·956	29·872	29·828	29·769	29·706	29·726	29·722	29·753	29·852	29·950	29·966	29·836	+·060
30·096	30·010	29·955	29·926	...	...	...	...	29·857	29·956	30·028	30·055	...	...
23·338	23·302	23·268	23·267	...	...	...	...	...	23·312	23·312	23·315	...	...
30·113	30·078	29·960	29·932	29·908	29·798	29·763	29·739	29·790	29·944	29·987	30·046	29·920	−·100
30·066	30·016	29·975	29·869	29·865	29·818	29·770	29·764	29·865	29·957	30·000	30·016	29·918	...
30·060	30·030	29·958	29·878	29·880	29·862	29·766	29·773	29·880	29·964	30·006	30·045	29·925	...
30·064	30·030	29·980	29·892	29·906	29·886	29·788	29·787	29·902	29·993	30·020	30·045	29·941	...
30·056	30·018	29·941	29·910	29·910	29·873	29·786	29·802	29·894	29·965	29·997	30·024	29·931	...
30·019	29·960	29·882	29·842	29·824	29·782	29·699	29·721	29·820	29·906	29·950	29·985	29·866	...
30·230	30·187	29·994	29·896	29·963	29·963	29·868	29·911	29·923	30·022	30·045	29·986	29·998	...
30·020	29·980	29·874	29·843	29·892	29·912	29·920	29·926	29·956	29·950	29·961	29·937	29·931	...
30·055	30·023	29·950	29·886	29·936	29·970	29·970	29·945	29·984	29·984	29·972	29·990	29·973	−·050
30·084	30·043	30·000	29·916	29·950	29·982	29·995	29·975	29·996	29·973	29·970	30·010	29·991	...
29·162	29·080	29·031	28·967	29·004	29·050	29·051	29·038	29·079	29·042	29·048	29·056	29·050	−·020
27·851	27·803	27·710	27·676	27·725	27·770	27·805	27·806	27·814	27·781	27·776	27·770	27·774	...
29·992	29·858	29·763	29·717	29·755	29·788	29·780	29·765	29·787	29·783	29·790	29·820	29·800	...
30·076	30·030	29·930	29·882	29·914	29·946	29·935	29·910	29·952	29·950	29·950	29·997	29·956	...
29·770	29·703	29·595	29·552	29·564	29·581	29·560	29·551	29·594	29·606	29·626	29·687	29·616	+·040
29·997	29·961	29·855	29·824	29·822	29·836	29·826	29·820	29·845	29·858	29·846	29·905	29·862	+·030
29·911	29·890	29·781	29·733	29·743	29·775	29·755	29·735	29·771	29·783	29·782	29·843	29·792	...
30·187	30·134	30·022	30·013	30·011	30·023	29·993	29·993	30·030	30·043	30·038	30·110	30·046	+·030
27·138	27·095	27·020	27·008	27·037	27·111	27·130	27·130	27·140	27·095	27·068	27·060	27·086	−·040
27·056	27·010	26·950	26·940	27·004	27·045	27·060	27·046	27·054	27·021	27·002	26·993	27·015	...
29·766	29·697	29·591	29·531	29·532	29·553	29·580	29·574	29·600	29·628	29·650	29·671	29·614	+·020
27·550	27·512	27·404	27·387	27·408	27·441	27·475	27·473	27·493	27·470	27·462	27·495	27·464	+·030
27·343	27·315	27·234	27·227	27·254	27·300	27·302	27·304	27·310	27·290	27·253	27·295	27·307	...
28·512	28·484	28·380	28·372	28·281	28·426	28·421	28·406	28·424	28·417	28·407	28·452	28·424	...
...	...	...	...	...	...	28·536	28·601	...	...	...	...	...	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Murzuk, . .	Sahara	$\frac{5}{12}$	1865–66	9 : 3	25	54	14	12	1560
Mogador, . .	Morocco	7	1866–71, 78–79	M.P.	31	30	—9	44	54
Casa Bianca, .	do.	1	1867–68	various.	30	0	—9	30	[0]
Cape Juby, . .	do.	5	1883–88	9 : 9	27	58	—12	52	23
Angra do Heroisma,	Azores	15	1870–84	M.P.	38	36	—27	15	177
Horta de Fayal .	do.	15	do.	10 : 6	38	32	—28	39	208
Ponta Delgada, .	do.	15	do.	M.P.	37	45	—25	41	20
Funchal, . .	Madeira	15	do.	do.	32	38	—16	55	83
Orotava, . .	Canaries	1	1856–57	9 :	28	27	—16	38	70
Laguna-di-Teneriffe,	do.	6	1877–82	9 : 3	28	12	—16	24	1790
Ste. Croix de la Palme,	do.	5	1878–84	11 : 7	28	4	—17	47	113
Praya, . . .	Cape Verde Is.	5	1875–79	9 : 3	14	54	—23	31	112
St. Nicholas, .	do.	$\frac{3}{4}$	1868–69	: 1	16	40	—24	15	2280
St. Louis, . .	Senegambia	5	1874–78	10 : 4	16	7	—16	30	16
R. Gambia, . .	do.	1	...	9 : 3	13	20	—16	40	6
Gorée, . . .	do.	10	1856–65	10 : 4	14	40	—17	25	20
Kita, . . .	do.	1	1883	6 : 2, 9	13	4	—11	48	1090
Bammaku, . .	do.	1	1883–84	do.	11	54	—7	57	940
Abdezenga, . .	do.	$\frac{1}{6}$	1867	9 : 3	8	54	6	48	1467
Nango (Upper Niger)	Soudan	1	1880–81	6, 10 : 2, 6	13	0	—6	40	945
Kuka, . . .	do.	$\frac{1}{2}$	1866	9 : 3	15	52	13	23	1168
Kuka, . . .	do.	$\frac{7}{12}$	1870–71	S-R. 2 : 9	12	52	13	23	920
Chartum, . .	do.	$1\frac{1}{2}$	1852, 78	6 : 3, 8	15	36	32	36	1273
Ladò and Gondokoro,	do.	3–4	1853–54, 80	7 : 2, 9	5	2	31	50	1526
Freetown, . .	Sierra Leone	7	1877–83	9 : 3	8	30	—13	9	224
St. George d'Elmina,	Guinea	3	1859–62	6 : 2, 9	5	5	—1	20	59
Christiansborg, .	do.	$7\frac{1}{2}$	1829–40	various.	5	24	0	10	66
Akassa, . .	do.	$1\frac{1}{3}$	1887–88	9 : 9	4	20	6	20	21
Lagos, . . .	do.	$1\frac{1}{2}$	1886–87	8 : 2	6	12	3	25	25
Fernando Po, .	do.	$4\frac{1}{2}$	1859–63	M.P.	3	46	8	35	98
St. Thomas, . .	do.	11	1872–84	9 : 3	0	20	6	43	16
Gabun, . .	Lower Guinea	3	1882–85	6 : 2, 9	0	25	9	35	66
Ponta da Lenha, .	do.	$\frac{1}{2}$	1884	7 : 2, 9	—5	57	12	40	30
San Salvador, .	do.	$3\frac{1}{2}$	1883–86	M.P.	—6	17	14	53	1860
M'Boma, . .	do.	$\frac{3}{4}$	1884–85	do.	—5	47	13	11	80
Vivi, . . .	do.	$1\frac{1}{3}$	1882–83	7 : 2, 9	—4	40	13	49	374
Chinchoxo, . .	do.	$2\frac{1}{6}$	1874–76	6 : 2, 10	—5	9	12	3	39
St. Paul de Loanda,	do.	4	1879–82	9 : 3	—8	49	13	7	194
Malange, . .	do.	3	1879–81	7 : 2, 9	—9	33	16	38	3850
Walfischbay, .	do.	1	1886	7 : 1, 9	—22	56	14	26	10
Ascension, . .	Atlantic	2	1863–66	6, 9, N. : 4	—7	55	14	25	53
St. Helena, . .	do.	8	1853–61	$9\frac{1}{2}$: $3\frac{1}{2}$	—15	55	—5	43	40
St. Helena, . .	do.	$3\frac{1}{2}$	1844–47	two-hourly	—15	55	—5	43	1763
Port Nolloth, .	Cape Colony	$\frac{5}{12}$	1876–77	8 : 8	—29	15	16	25	[0]
Springbok, . .	do.	$3\frac{1}{2}$	1882–86	do.	—29	40	17	53	3150
Sutherland, . .	do.	15	1870–84	do.	—32	24	20	40	4780
Wellington, . .	do.	15	do.	do.	—33	38	19	0	430
Worcester, . .	do.	15	do.	do.	—33	40	19	27	780
Cape Town, . .	do.	15	do.	M.P.	—33	56	18	27	37
Wynberg, . .	do.	15	do.	8 : 8	—34	0	18	28	250

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
28·463	28·351	28·252	...	...	...	...	...	...	...	28·400	28·394	...	...
30·126	30·134	30·004	30·016	29·977	30·028	29·977	29·957	30·008	30·004	30·028	30·060	30·010	...
30·268	30·335	30·001	30·154	30·048	30·060	30·134	30·095	30·123	30·119	30·103	30·099	30·128	...
30·177	30·146	30·075	30·068	30·092	30·109	30·075	30·029	30·090	30·102	30·085	30·162	30·101	...
29·935	29·906	29·934	29·880	29·992	30·070	30·088	30·010	29·988	29·957	29·893	29·940	29·964	...
29·985	29·950	29·985	29·926	30·032	30·127	30·170	30·079	30·040	30·012	29·941	29·993	30·020	...
30·115	30·072	30·091	30·034	30·132	30·231	30·237	30·158	30·115	30·092	30·054	30·111	30·120	+·030
30·107	30·084	29·997	30·008	30·010	30·091	30·062	30·020	30·034	30·014	29·990	30·066	30·040	...
30·290	30·116	30·177	30·110	30·100	30·140	30·094	30·095	30·125	30·121	30·119	30·180	30·144	...
28·304	28·320	28·262	28·250	28·230	28·300	28·268	28·233	28·256	28·260	28·259	28·292	28·270	...
30·054	30·054	29·980	29·978	30·002	30·026	30·010	29·990	29·992	29·990	29·958	30·024	30·005	...
29·908	29·908	29·901	29·897	29·908	29·940	29·905	29·877	29·873	29·877	29·881	29·897	29·898	+·030
27·689	...	...	...	27·670	27·654	27·658	27·646	27·646	27·666	27·682	27·717	...	...
29·962	29·952	29·906	29·896	29·913	29·918	29·937	29·920	29·916	29·908	29·903	29·953	29·926	+·070
29·817	29·854	29·793	29·821	29·844	29·884	29·841	29·825	29·840	29·884	29·843	29·849	29·841	...
29·962	29·947	29·903	29·895	29·910	29·915	29·913	29·888	29·897	29·892	29·891	29·931	29·912	+·080
29·095	29·095	29·056	29·056	29·134	29·095	29·134	29·134	29·134	29·095	29·095	29·056	29·098	...
28·958	28·938	(28·920)	(28·920)	28·918	28·938	28·938	28·938	28·977	28·982	28·941	28·977	28·946	...
...	28·520	28·434	...	...	...	...	...	...	...	...	...	...	...
28·957	28·871	28·895	28·880	28·900	28·895	28·914	28·895	28·923	28·920	28·934	28·977	28·913	...
...	...	...	...	...	...	28·697	28·697	28·709	28·642	28·686	28·756	...	...
28·985	29·008	...	...	...	...	...	28·902	28·969	28·945	28·985	28·993	...	...
28·587	28·571	28·540	28·524	28·504	28·484	28·497	28·481	28·493	28·528	28·560	28·575	28·528	...
28·359	28·308	28·320	28·345	28·390	28·445	28·445	28·449	28·441	28·402	28·402	28·379	28·390	...
29·678	29·673	29·670	29·661	29·701	29·738	29·745	29·744	29·738	29·701	29·688	29·676	29·698	...
29·870	29·851	29·867	29·851	29·878	29·941	29·986	29·981	29·953	29·902	29·872	29·876	29·902	...
29·862	29·838	29·829	29·837	29·874	29·939	29·971	29·958	29·920	29·882	29·862	29·849	29·885	...
29·965	29·932	29·932	29·914	29·923	30·023	30·098	30·043	30·039	29·995	29·948	29·954	29·977	...
29·910	30·000	29·930	29·960	30·010	29·973	30·013	30·048	30·000	29·950	29·926	29·953	29·977	...
29·895	29·891	29·903	29·884	29·907	29·927	29·939	29·943	29·923	29·923	29·915	29·895	29·912	...
29·878	29·870	29·872	29·874	29·906	29·973	30·004	29·984	29·957	29·920	29·882	29·880	29·917	...
29·823	29·803	29·796	29·795	29·835	29·915	29·968	29·935	29·907	29·848	29·830	29·815	29·856	–·040
...	...	29·895	29·907	29·955	30·033	30·082	30·057	...	...	...	...	...	+·080
28·070	28·046	28·034	28·050	28·073	28·133	28·154	28·125	28·125	28·106	28·094	28·086	28·090	...
29·835	29·808	29·796	29·815	29·835	29·902	...	...	...	29·863	29·859	29·823	...	...
29·587	29·548	29·564	29·520	29·595	29·688	29·729	29·713	29·662	29·603	29·556	29·567	29·611	...
29·922	29·918	29·908	29·922	29·945	30·028	30·059	30·062	30·028	29·981	29·933	29·930	29·970	+·055
29·758	29·743	29·761	29·766	29·797	29·876	29·907	29·884	29·860	29·796	29·754	29·750	29·804	+·025
26·032	26·052	26·063	26·091	26·134	26·174	26·146	26·154	26·154	26·107	26·095	26·052	26·104	...
29·960	29·940	29·968	29·992	30·062	30·114	30·133	30·117	30·094	30·050	30·000	29·998	30·036	+·050
29·944	29·922	29·912	29·914	29·951	30·038	30·066	30·045	30·025	29·996	29·971	29·940	29·977	...
29·983	29·999	29·992	29·992	30·034	30·090	30·113	30·113	30·089	30·055	30·031	30·019	30·043	...
28·241	28·238	28·228	28·249	28·279	28·328	28·351	28·349	28·305	28·286	28·262	28·247	28·280	...
30·024	30·027	...	...	...	...	...	30·241	30·099	30·038	30·075	30·074	...	...
27·874	27·862	27·890	27·890	27·902	27·920	27·941	27·918	27·898	27·903	27·863	27·873	27·894	...
25·276	25·272	25·305	25·333	25·331	25·427	25·431	25·415	25·356	25·308	25·263	25·253	25·331	...
29·468	29·484	29·520	29·595	29·617	29·724	29·750	29·710	29·692	29·617	29·564	29·534	29·606	...
29·127	29·152	29·176	29·254	29·260	29·358	29·366	29·335	29·316	29·253	29·208	29·175	29·248	...
29·910	29·924	29·954	30·027	30·040	30·155	30·165	30·123	30·102	30·034	29·976	29·945	30·030	...
29·690	29·702	29·720	29·792	29·811	29·918	29·932	29·894	29·875	29·793	29·757	29·730	29·801	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. ° ′	Longitude. ° ′	Height, Feet.
Cape Agulhas, .	Cape Colony	15	1870–84	8 : 3	—34 55	20 18	66
Mossel Bay, . .	do.	15	do.	8 : 8	—34 11	22 9	105
Cape Francis, .	do.	15	do.	do.	—34 10	24 50	25
Port Elizabeth, .	do.	15	do.	do.	—33 57	25 37	181
East London, .	do.	15	do.	do.	—32 2	27 55	40
King William's Town,	do.	15	do.	do.	—32 51	27 22	1334
Graham's Town, .	do.	15	do.	do.	—33 20	26 33	1800
Cradock, . .	do.	15	do.	8 :	—32 11	25 38	2850
Aliwal, North, .	do.	15	do.	do.	—30 43	26 43	4400
Bloemfontein, .	do.	15	do.	do.	—28 56	26 19	4550
Kimberley, . .	do.	15	do.	do.	—28 48	25 2	4060
Molepolole, . .	do.	3	1881–83	8 : 8	—24 0	25 0	3750
Fort Napier, .	Natal	15	1870–84	9 : 3	—29 3	30 2	2300
Pietermaritzburg, .	do.	8	1858–65	do.	—29 30	30 2	2096
Durban, . .	do.	1	1884	do.	—29 50	31 0	150
Loureço Marques,	Sofala	$1\frac{3}{4}$	1876–78	8, N. : 8	—25 28	32 37	16
Zanzibar, . .	Zanzibar	8	1875–78, 1880–84	10 : 4	—6 10	39 11	23
Nossi-Bé, . .	Madagascar	1	1879–80	do.	—13 14	48 15	[0]
Tamatave, . .	do.	$\frac{1}{3}$	1863	9 : 4	—18 3	49 11	0
Réunion, . .	Indian Ocean	3	1883–85	$9\frac{1}{2}$: $3\frac{1}{2}$	—20 50	55 15	51
Mauritius, . .	do.	15	1870–84	M.P.	—20 6	57 33	various
Rodriguez, . .	do.	2	1885–86	9 : 3	—19 48	63 10	10
Seychelles, . .	do.	2	do.	9, 10 : 3, 4	—4 0	57 0	[0]
Kerguelen, . .	do.	$\frac{2}{3}$	1840, 74–75	hourly	—49 25	69 54	50
St. Paul's Island, .	do.	$\frac{1}{2}$	various	M.P.	—35 to 40	75 to 88	0
Derby, . . .	West Australia	$1\frac{1}{2}$	1884–85	9, N. : 3	—17 18	123 39	17
Cossack, . .	do.	6	1880–85	do.	—20 40	117 8	19
Carnarvon, . .	do.	6	1885	do.	—24 52	113 39	20
Geraldton, . .	do.	6	do.	do.	—28 47	114 26	10
York, . . .	do.	6	do.	do.	—31 53	116 47	580
Perth, . . .	do.	10	1876–85	do.	—31 57	115 52	47
Perth, . . .	do.	6	1880–85	do.	—31 57	115 52	47
Freemantle, . .	do.	6	do.	do.	—33 2	115 45	16
Rottnest, . .	do.	6	do.	do.	—32 0	115 35	47
Bunbury, . .	do.	6	do.	do.	—33 19	115 39	18
Albany, . .	do.	6	do.	do.	—35 2	117 54	88
Port Darwin, .	South Australia	7	1876–82	9 : 3	—12 28	130 51	70
Daly Waters, .	do.	7	do.	do.	—16 16	133 22	750
Alice Springs, .	do.	5	1878–82	do.	—23 38	133 37	2100
Port Augusta, .	do.	15	1870–84	do.	—32 29	137 45	10
Eucla, . .	do.	15	do.	do.	—31 45	128 58	7
Streaky Bay, .	do.	15	do.	do.	—32 48	134 13	43
Cape Borda, .	do.	15	do.	do.	—35 45	136 35	506
Kapunda, . .	do.	15	do.	do.	—34 21	138 55	803
Adelaide, . .	do.	15	do.	do.	—34 57	138 35	140
Mount Gambier, .	do.	15	do.	do.	—37 50	140 50	130
Cape Northumberland	do.	15	do.	do.	—38 5	140 40	117
Portland, . .	Victoria	15	do.	6, 9 : 3, 9	—38 21	141 32	37
Cape Otway, .	do.	15	do.	do.	—38 54	143 37	270
Port Albert, .	do.	15	do.	do.	—38 40	147 0	10

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·880	29·912	29·950	29·992	30·005	30·116	30·128	30·093	30·072	30·000	29·948	29·924	30·000	...
29·836	29·866	29·886	29·958	29·960	30·072	30·062	30·054	30·016	29·954	29·912	29·874	29·954	...
29·956	29·990	30·012	30·078	30·095	30·207	30·190	30·125	30·112	30·054	30·000	29·957	30·065	...
29·782	29·810	29·846	29·915	29·907	30·040	30·019	29·963	29·942	29·890	29·845	29·776	29·895	...
29·875	29·924	29·957	30·018	30·050	30·200	30·142	30·118	30·102	30·014	29·957	29·890	30·021	...
28·552	28·588	28·610	28·675	28·690	28·810	28·772	28·724	28·708	28·635	28·578	28·545	28·657	...
28·038	28·085	28·126	28·162	28·156	28·276	28·250	28·266	28·201	28·151	28·080	28·040	28·140	...
27·070	27·068	27·124	27·166	27·193	27·278	27·293	27·228	27·200	27·142	27·081	27·060	27·159	...
25·601	25·646	25·680	25·749	25·772	25·877	25·868	25·800	25·758	25·696	25·628	25·600	25·723	...
25·460	25·504	25·540	25·610	25·628	25·734	25·712	25·646	25·600	25·545	25·481	25·460	25·576	...
25·944	25·975	26·024	26·086	26·108	26·230	26·206	26·136	26·096	26·042	25·970	25·950	26·065	...
26·298	26·320	26·331	26·416	26·394	26·485	26·471	26·395	26·363	26·325	26·293	26·300	26·366	...
27·574	27·584	27·640	27·683	27·717	27·814	27·797	27·755	27·727	27·674	27·604	27·574	27·679	...
27·786	27·802	27·844	27·914	27·937	27·994	28·001	27·981	27·905	27·864	27·822	27·795	27·887	...
29·951	29·931	30·023	30·097	30·117	30·294	30·292	30·288	30·128	30·091	29·993	30·036	30·103	...
29·888	29·878	29·961	30·020	30·060	30·218	30·174	30·107	29·993	30·022	30·020	29·871	30·018	...
29·871	29·871	29·870	29·898	29·973	30·054	30·071	30·057	30·033	29·979	29·914	29·889	29·957	...
29·916	29·942	29·938	29·951	29·971	29·991	30·005	30·045	30·040	30·016	29·981	30·028	29·985	...
...	...	...	...	...	...	...	30·077	30·016	30·024	29·977	...	...	...
29·910	29·898	29·941	29·963	30·071	30·142	30·175	30·170	30·176	30·100	30·060	29·992	30·050	...
29·946	29·932	29·970	30·014	30·088	30·171	30·207	30·216	30·197	30·135	30·067	30·005	30·079	...
29·966	29·922	29·976	29·980	30·074	30·186	30·210	30·219	30·223	30·151	30·104	30·008	30·085	...
29·928	29·901	29·905	29·887	29·890	29·930	29·960	29·941	29·983	29·983	29·950	29·938	29·933	...
29·406	29·610	...	...	29·491	29·355	29·575	29·474	...	...	29·658	29·462	...	...
30·030	...	...	...	...	29·945	29·928	30·057	...	...	30·024	30·021	...	...
29·784	29·731	29·790	29·929	29·885	29·998	29·986	29·967	29·937	29·926	29·806	29·721	29·874	+·030
29·708	29·718	29·762	29·892	29·955	30·024	30·042	29·997	29·948	29·891	29·800	29·727	29·872	...
29·816	29·854	29·892	29·987	30·030	30·056	30·116	30·064	30·070	30·000	29·887	29·837	29·992	...
29·857	29·870	29·910	29·992	30·040	30·084	30·130	30·075	30·085	30·035	29·938	29·897	29·993	...
29·875	29·898	29·963	30·010	30·041	30·080	30·126	30·046	30·061	30·025	29·910	29·865	29·992	...
29·917	29·937	29·998	30·088	30·070	30·118	30·143	30·107	30·111	30·076	29·986	29·945	30·041	...
29·923	29·937	29·977	30·042	30·065	30·101	30·157	30·085	30·114	30·082	29·978	29·941	30·034	...
29·944	29·954	29·979	30·041	30·072	30·091	30·135	30·088	30·088	30·089	29·980	29·946	30·034	...
29·915	29·930	29·983	30·020	30·041	30·072	30·122	30·050	30·081	30·055	29·967	29·917	30·013	...
29·946	29·961	29·998	30·015	30·051	30·070	30·131	30·062	30·101	30·079	29·999	29·943	30·014	...
29·969	30·011	30·016	30·015	30·010	30·005	30·064	30·005	30·056	30·058	29·999	29·943	30·013	...
29·769	29·801	29·815	29·878	29·904	29·966	30·005	29·980	29·949	29·911	29·854	29·807	29·887	+·050
29·742	29·796	29·834	29·943	30·004	30·080	30·120	30·064	29·986	29·908	29·850	29·808	29·928	...
29·813	29·877	29·958	30·093	30·160	30·231	30·240	30·188	30·118	29·998	29·928	29·861	30·039	−·090
29·875	29·900	30·059	30·124	30·106	30·096	30·218	30·066	30·088	30·030	29·975	29·905	30·052	...
29·886	29·916	30·058	30·130	30·082	30·070	30·192	30·052	30·060	30·020	29·960	29·900	30·042	+·020
29·912	29·950	30·074	30·110	30·083	30·073	30·203	30·057	30·080	30·036	29·982	29·935	30·041	...
29·925	29·966	30·078	30·101	30·040	30·012	30·133	30·000	30·034	30·000	29·974	29·921	30·015	...
29·901	29·965	30·072	30·145	30·098	30·083	30·200	30·117	30·076	30·035	29·973	29·915	30·049	+·035
29·934	29·974	30·077	30·135	30·100	30·133	30·203	30·103	30·088	30·040	30·000	29·943	30·062	...
29·960	29·980	30·084	30·108	30·076	30·008	30·120	29·988	30·004	30·018	29·962	29·900	30·013	+·050
29·954	29·990	30·074	30·111	30·073	30·006	30·090	29·960	29·996	30·013	29·951	29·892	30·010	...
29·917	29·968	30·030	30·064	30·002	30·011	30·081	29·976	29·967	29·954	29·908	29·864	29·978	...
29·663	29·702	29·764	29·802	29·750	29·740	29·828	29·710	29·698	29·688	29·636	29·616	29·716	−·030
29·911	29·974	30·033	30·069	30·022	30·019	30·091	29·988	29·962	29·952	29·913	29·852	29·982	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Wilson's Promontory,	Victoria	15	1870–84	6, 9 : 3, 9	—39 8	146 23	300
Gabo Island, .	do.	15	do.	do.	—37 35	149 30	50
Melbourne, . .	do.	15	do.	do.	—37 50	144 50	91
Ballarat, . .	do.	15	do.	do.	—37 34	143 53	1438
Sandhurst, . .	do.	15	do.	do.	—36 43	144 21	758
Echuca, . .	do.	15	do.	do.	—36 5	144 48	314
Wentworth . .	New South Wales	15	do.	9 :	—34 8	142 0	144
Deniliquin, . .	do.	15	do.	do.	—35 32	145 2	410
Albury, . .	do.	15	do.	do.	—36 6	147 0	572
Eden, . . .	do.	15	do.	do.	—37 0	149 59	107
Cape St. George, .	do.	15	do.	do.	—35 12	150 45	175
Goulburn, . .	do.	15	do.	do.	—34 45	149 45	2129
Sydney, . .	do.	15	do.	do.	—33 52	151 11	155
Windsor, . .	do.	15	do.	do.	—32 55	151 50	53
Bathurst, . .	do.	15	do.	do.	—33 24	149 37	2200
Newcastle, . .	do.	15	do.	do.	—32 55	151 50	112
Port Macquarie, .	do.	15	do.	do.	—31 25	152 54	53
Armidale . .	do.	15	do.	do.	—30 34	151 46	3278
Forbes, . .	do.	15	do.	do.	—33 27	148 5	1120
Bourke, . .	do.	15	do.	do.	—30 3	145 58	456
Thergomindal, .	do.	15	do.	do.	—28 0	142 30	450
Brisbane, . .	Queensland	15	do.	9 : 3	—27 28	153 6	130
Moreton Bay, .	do.	15	do.	do.	—27 1	153 28	320
Toowoomba, . .	do.	15	do.	8 : 2	—27 34	152 10	1960
Somerset, Cape York,	do.	2⅓	1865–67	9 : 3	—10 44	142 36	70
Goodie Island, .	do.	1	1880	do.	—10 33	142 10	300
Sweer's Island, .	do.	2½	1866–68	do.	—15 0	136 0	[0]
Kent's Group, .	Tasmania	5	1861–66	6, N. : 6	—39 29	147 25	280
Hobart Town, .	do.	5	do.	do.	—42 52	147 21	37
Hobart Town, .	do.	15	1870–84	various	—42 52	147 21	37
Port Arthur, .	do.	5	1861–66	6, N. : 6	—43 9	147 54	55
Mongonui, . .	New Zealand	15	1870–84	9.30 :	—35 1	173 28	70
Auckland, . .	do.	15	do.	do.	—36 50	174 51	258
Taranaki, . .	do.	15	do.	do.	—39 4	174 5	42
Napier, . .	do.	15	do.	do.	—39 29	176 55	8
Wellington, . .	do.	15	do.	do.	—41 16	174 47	140
Nelson, . .	do.	15	do.	do.	—41 16	173 19	34
Cape Campbell .	do.	15	do.	do.	—41 43	174 18	7
Christchurch, .	do.	15	do.	do.	—43 43	172 39	21
Hokitika, . .	do.	15	do.	do.	—42 42	170 59	12
Dunedin, . .	do.	15	do.	do.	—45 52	170 31	500
Southland, . .	do.	15	do.	do.	—46 17	168 20	79
Chatham Islands, .	do.	3	1879–81	do.	—43 52	176 42	100
Auckland Island,	do.	5 M.	1874–75	do.	—50 32	166 5	10
Port de France, .	New Caledonia	2	1863–64	6, 10 : 1, 4, 10	—22 16	166 36	22
Solomon Islands, .	Pacific Ocean	1½	1882–84	...	—9 0	160 0	0
Suva & Levuka, Fiji,	do.	9	1877–85	10 : 4	—18 30	179 0	77
Upolu, . .	do.	8	1851–58	6, 9, N. : 3, 8	—13 51	—171 54	20
Apia, . . .	do.	1	1864	6 : 4, 8	—13 50	—171 44	0
Tongatabu, . .	do.	3	1872–74	4, 8, N. : etc.	—21 10	—174 50	0

Jan.	Feb.	Mar.	April.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·605	29·675	29·732	29·755	29·715	29·707	29·781	29·668	29·672	29·655	29·604	29·535	29·675	+·085
29·838	29·888	29·936	29·959	29·908	29·918	29·968	29·900	29·902	29·870	29·802	29·754	29·887	+·020
29·843	29·893	29·968	30·013	29·976	29·977	30·052	29·952	29·928	29·902	29·847	29·800	29·929	...
28·429	28·481	28·554	28·583	28·540	28·536	28·589	28·508	28·489	28·473	28·429	28·390	28·500	...
29·120	29·161	29·244	29·305	29·271	29·285	29·353	29·266	29·233	29·202	29·141	29·095	29·223	...
29·556	29·611	29·703	29·762	29·734	29·760	29·833	29·751	29·715	29·660	29·591	29·552	29·686	+·050
29·923	29·990	30·088	30·140	30·086	30·121	30·213	30·143	30·095	30·078	30·032	29·952	30·072	−·060
29·907	29·956	30·038	30·121	30·101	30·137	30·190	30·129	30·078	30·029	29·984	29·915	30·049	−·025
30·003	30·058	30·128	30·140	30·117	30·130	30·166	30·126	30·058	30·054	29·991	29·945	30·076	...
29·894	29·998	30·058	30·074	30·040	30·018	30·082	30·008	29·997	29·974	29·924	29·863	29·994	...
29·931	29·962	30·053	30·072	30·026	30·036	30·096	30·027	30·006	29·988	29·943	29·881	30·004	...
29·954	30·015	30·102	30·138	30·118	30·160	30·184	30·117	30·056	30·058	29·964	29·905	30·064	...
29·966	30·010	30·083	30·125	30·086	30·107	30·168	30·122	30·080	30·026	29·951	29·915	30·053	...
29·904	29·944	30·019	30·064	30·022	30·043	30·102	30·066	30·018	29·978	29·897	29·852	29·992	...
29·900	29·950	30·044	30·112	30·108	30·130	30·196	30·100	30·046	30·033	29·940	29·880	30·037	...
29·943	30·002	30·065	30·114	30·078	30·112	30·150	30·104	30·067	30·042	29·956	29·912	30·045	+·030
29·971	30·008	30·072	30·098	30·064	30·060	30·114	30·104	30·058	30·037	29·983	29·928	30·041	...
29·935	29·987	30·040	30·078	30·068	30·073	30·152	30·122	30·074	30·057	30·000	29·928	30·042	+·020
29·988	30·006	30·076	30·140	30·110	30·123	30·167	30·128	30·071	30·036	29·976	29·924	30·062	...
29·910	29·956	30·052	30·132	30·118	30·128	30·172	30·126	30·066	30·050	29·948	29·906	30·047	...
29·940	29·955	30·040	30·120	30·138	30·174	30·198	30·154	30·120	30·100	30·024	29·996	30·080	...
29·893	29·927	29·987	30·065	30·060	30·113	30·125	30·118	30·074	30·045	29·976	29·912	30·025	...
29·910	29·937	29·979	30·068	30·058	30·106	30·111	30·116	30·078	30·050	29·994	29·928	30·018	+·030
29·915	29·930	29·984	30·064	30·046	30·071	30·070	30·062	30·033	30·010	29·989	29·921	30·007	+·090
29·788	29·785	29·847	29·795	29·852	29·914	29·916	29·933	29·907	29·898	29·868	29·780	29·857	...
29·771	29·824	29·867	29·917	29·960	29·970	29·998	30·012	29·970	29·970	29·938	29·904	29·925	...
29·748	29·732	29·878	29·933	29·984	30·039	30·047	30·019	30·008	29·960	29·838	29·921	29·925	...
29·620	29·650	29·766	29·764	29·686	29·776	29·588	29·652	29·600	29·610	29·598	29·564	29·656	...
29·807	29·849	29·973	29·996	29·927	29·892	29·855	29·912	29·789	29·824	29·788	29·756	29·873	...
29·876	29·926	29·989	29·998	29·951	29·908	29·970	29·838	29·875	29·848	29·815	29·768	29·897	...
29·791	29·829	29·865	29·835	29·747	29·823	29·654	29·700	29·647	29·727	29·687	29·719	29·752	...
29·887	29·941	30·019	30·015	29·913	29·879	29·893	29·924	29·989	29·955	29·930	29·903	29·937	...
29·657	29·727	29·807	29·803	29·703	29·649	29·656	29·688	29·763	29·739	29·707	29·666	29·713	...
29·875	29·950	30·040	30·028	29·920	29·885	29·876	29·887	29·950	29·918	29·904	29·884	29·927	...
29·870	29·984	30·050	30·063	29·943	29·914	29·894	29·907	29·965	29·916	29·914	29·856	29·940	...
29·725	29·832	29·912	29·914	29·794	29·754	29·732	29·733	29·787	29·752	29·734	29·684	29·780	...
29·875	29·971	30·058	30·048	29·905	29·867	29·855	29·878	29·930	29·900	29·883	29·825	29·916	+·055
29·859	29·950	30·045	30·058	29·925	29·910	29·896	29·874	29·927	29·916	29·890	29·866	29·926	−·100
29·825	29·947	30·027	30·040	29·906	29·883	29·883	29·862	29·893	29·845	29·851	29·773	29·895	...
29·882	29·980	30·072	30·066	29·934	29·892	29·875	29·881	29·945	29·911	29·923	29·854	29·935	...
29·270	29·407	29·480	29·485	29·344	29·344	29·326	29·334	29·350	29·290	29·303	29·232	29·387	+·020
29·708	29·833	29·904	29·936	29·781	29·776	29·755	29·764	29·769	29·700	29·710	29·652	29·774	...
29·820	29·830	29·953	29·963	29·835	29·695	29·825	29·837	29·935	29·750	29·713	29·747	29·824	...
29·532	29·725	...	...	...	...	...	...	...	29·697	29·579	29·764	...	...
29·878	29·910	29·973	29·973	30·072	30·084	30·096	30·045	30·085	29·997	29·973	29·897	30·000	−·035
...	...	30·000	29·993	30·009	29·998	30·023	30·019	30·009	29·982	...	...	...	...
29·852	29·870	29·900	29·947	29·991	30·028	30·013	30·046	30·046	30·040	29·944	29·880	29·963	...
29·910	29·910	29·940	29·960	29·990	30·010	30·020	30·020	30·030	30·010	29·960	29·920	29·973	+·030
29·864	29·938	29·925	29·960	30·000	30·031	30·003	30·033	30·022	30·012	29·949	29·909	29·971	+·080
29·920	29·940	29·980	29·980	30·040	30·110	30·070	30·060	30·080	30·020	30·030	29·980	30·000	+·090

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Tahiti, . . .	Pacific Ocean	5	1855–60	4 daily obs.	−17 32	−149 34	[0]
Rapa, . . .	do.	1½	1867–69	6, 9, N. : 3, 8	−27 36	−144 11	0
Honolulu, . .	do.	2⅙	1885–87	10 : 4	21 18	−157 50	32
Honolulu, . .	do.	6	1837–38, '69–72	S-R. : 2	21 18	−157 50	[0]
Wayprecht and Payer's Exped.,	Arctic	2	1872–74	M.P.	77 to 79	54 to 65	0
Pitlekij, . .	do.	¾	1878–79	M.P.	67 5	−173 23	0
Sagaster, . .	do.	2	1882–84	hourly	73 23	124 5	16
Franz Josef's Land, . .	do.	1	1873–74	four hourly	79 38	60 4	0
Mosselbai, . .	do.	1	1872–73	M.P.	79 53	16 4	33
Thorsden . .	do.	1	1882–83	hourly	78 29	15 42	0
Dickson's Haven, .	do.	1	?	M.P.	78 48	14 55	0
Karmakuli, . .	do.	1	1882–83	hourly	72 23	52 42	23
Sodankylå, . .	do.	2	1882–84	do.	67 27	26 36	594
Bossekop, . .	do.	1	1882–83	do.	69 57	23 15	98
Jan Mayen, . .	do.	1	do.	do.	70 59	−8 28	35
Sabine Island, .	do.	1	1869–70	two hourly	74 32	−18 49	0
Godthaab, . .	do.	1	1882–83	hourly	64 11	−51 46	86
Ivigtut, . .	Greenland	15	do.	8 : 2, 9	61 12	−48 11	16
Frederikshaab, .	do.	4	1856–60	Noon	62 0	−49 24	[0]
Godthaab, . .	do.	15	1870–84	8 : 2, 9	64 11	−51 46	37
Jacobshaven, .	do.	15	do.	do.	69 19	−50 55	41
Upernavik, . .	do.	15	do.	8 : 2, 8	72 47	−55 53	39
Wolstenholm Sd. .	Arctic	1	1849–50	4, 8, 12 : etc.	76 34	−68 45	0
Port Foulke, .	do.	1	1860–61	hourly	78 18	−73 0	0
Van Rensseller, .	do.	2	1853–54	do.	78 37	−70 53	0
Fort Conger, .	do.	2	1881–83	do.	81 44	−64 45	0
The Discovery, .	do.	1	1875–76	do.	81 44	−65 3	0
The Alert, . .	do.	1	do.	do.	82 27	−61 22	0
Northumberland Sd.,	do.	1	1852–53	two hourly	76 52	−97 0	0
Winter Harbour, .	do.	1	1819–20	do.	74 47	−110 48	0
Wellington Channel,	do.	1	1852–53	do.	75 37	−92 22	0
Griffith Island, .	do.	1	1850–51	do.	74 34	−95 20	0
Port Leopold, .	do.	1	1848–49	do.	73 50	−90 12	0
Walker Bay, .	do.	1	1851–52	4, 8, 12 : etc.	71 35	−117 39	0
Cambridge Bay, .	do.	1	1852–53	do.	69 3	−105 12	0
Port Bowen, .	do.	1	1824–25	two hourly	73 13	−88 55	0
Port Kennedy, .	do.	1	1858–59	hourly	72 1	−94 14	0
Felix Harbour, .	do.	1	1829–30	do.	69 59	−92 1	0
Victoria Harbour,	do.	1	1830–31	do.	70 00	−91 35	0
Munday Harbour, .	do.	1	1831–32	do.	70 18	−91 40	0
Means of these 3,	do.	2½	1829–32	do.	70 6	−91 45	0
Dealy, . . .	do.	1	1852–53	3, 9 : 3, 9	74 56	−108 49	0
Mercy Bay, . .	do.	1½	1851–53	two hourly	74 6	−117 55	0
Princess Royal Island, . .	do.	1	1850–51	do.	72 47	−117 35	0
Beechy Island, .	do.	2	1852–54	4, 8, 12 : etc.	74 43	−91 54	0
Winter Island, .	do.	1	1821–22	two hourly	66 11	−83 10	0

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·938	29·916	29·926	29·934	29·980	29·991	30·013	30·036	30·038	30·016	29·983	29·957	29·977	+·070
29·974	29·976	29·967	30·066	30·056	29·988	29·998	29·880	29·850	30·194	30·054	29·946	29·988	...
30·028	30·007	30·086	30·088	30·102	30·085	30·083	30·026	30·023	30·030	30·098	30·090	30·062	...
30·050	30·094	30·095	30·121	30·121	30·104	30·087	30·063	30·069	30·053	30·067	30·071	30·083	+·050
29·548	29·544	29·627	29·898	30·004	29·867	29·886	29·815	29·745	29·749	29·898	29·843	29·788	...
29·638	30·237	29·894	29·793	29·912	29·779	...	...	...	29·837	29·6 78	29·960	...	...
29·946	30·104	30·124	30·046	29·792	29·668	29·836	29·782	29·695	29·755	29·876	29·935	29·880	...
29·134	29·611	29·508	29·863	30·071	29·863	29·819	29·784	29·729	29·634	29·729	29·615	29·697	...
29·59 1	29·690	29·831	30·056	30·130	29·768	(29855)	29·977	29·808	29·834	29·812	29·855	29·823	...
29·600	29·520	29·890	29·949	30·038	29·922	29·997	29·910	29·731	29·928	29·884	30·120	29·874	...
29·828	29·912	29·721	29·304	30·071	29·913	29·810	...	...	30·099	29·965	30·174	...	...
29·639	29·705	29·579	30·147	29·958	29·880	29·724	29·867	29·884	30·024	29·905	29·965	29·856	...
29·342	29·416	29·416	29·473	29·414	29·435	29·417	29·438	29·433	30·427	29·408	29·396	29·418	...
29·520	29·638	29·557	29·958	29·735	29·866	29·741	29·631	29·729	29·941	29·748	29·788	29·738	...
29·410	29·288	29·977	29·760	29·784	29·938	29·686	29·686	29·638	29·780	29·611	29·890	29·705	...
29·784	29·977	30·166	29·867	29·875	29·918	29·709	29·948	29·859	29·867	29·764	29·800	29·886	...
29·114	29·097	29·745	29·646	29·794	29·737	29·749	29·725	29·563	29·426	29·622	29·705	29·577	...
29·378	29·402	29·623	29·721	29·788	29·760	29·756	29·729	29·700	29·623	29·615	29·488	29·632	...
29·424	29·371	29·652	29·815	29·872	29·850	29·732	29·700	29·653	29·666	29·640	29·495	29·656	...
29·410	29·441	29·658	29·760	29·792	29·764	29·756	29·733	29·686	29·627	29·611	29·508	29·646	...
29·520	29·579	29·768	29·851	29·835	29·776	29·737	29·737	29·690	29·686	29·686	29·600	29·705	...
29·560	29·623	29·808	29·910	29·867	29·792	29·737	29·745	29·690	29·678	29·705	29·630	29·729	...
29·845	29·731	29·998	29·716	29·834	29·626	29·599	29·775	29·766	29·605	29·828	29·669	29·749	...
29·834	29·747	29·816	30·085	29·985	29·678	29·691	29·662	29·684	29·618	30·087	30·032	29·824	...
29·778	29·848	29·750	29·903	29·942	29·719	29·741	29·694	29·658	29·755	29·758	29·753	29·775	...
29·796	29·672	29·894	30·099	30·066	29·878	29·790	29·826	29·772	29·897	29·859	29·922	29·872	...
29·674	29·993	30·099	30·327	29·930	29·800	29·594	29·709	29·705	29·981	30·193	29·646	29·886	...
29·607	29·981	30·095	30·300	29·914	29·804	29·599	29·599	29·682	29·949	30·154	29·615	29·867	...
29·696	30·050	30·079	30·022	29·910	29·715	29·610	29·658	29·778	29·939	30·047	29·886	29·866	...
30·080	29·770	29·800	29·980	30·110	29·820	29·670	29·730	29·900	29·810	29·940	29·860	29·872	...
29·614	29·716	29·837	30·005	29·980	29·756	29·638	29·730	29·741	29·791	29·721	29·810	29·778	...
29·732	29·832	29·847	30·077	29·994	29·985	29·805	29·870	29·684	29·946	29·911	29·839	29·877	...
29·817	29·823	29·906	29·958	29·988	29·838	29·671	29·680	29·738	29·840	29·845	29·693	29·816	...
29·902	29·854	30·164	30·027	30·005	29·815	29·756	29·852	29·932	29·863	30·090	30·112	29·948	...
29·801	29·952	30·056	30·017	30·031	29·807	29·675	29·715	29·947	29·950	30·011	29·929	29·908	...
29·762	29·887	30·108	30·068	30·051	29·889	29·817	29·683	29·689	29·962	29·899	29·869	29·890	...
29·972	29·924	30·163	30·170	30·001	29·903	29·695	29·652	30·000	29·793	30·044	29·865	29·932	...
29·693	30·117	30·011	30·003	30·242	30·105	29·860	29·859	...	...	29·683	29·896	...	...
30·129	29·972	29·903	29·977	30·040	29·942	29·920	29·856	29·834	29·889	30·027	30·083	29·964	...
29·644	29·859	29·984	30·004	...	...	...	...	29·815	30·026	30·114	29·777	...	...
29·822	29·983	29·960	29·995	30·141	30·023	29·890	29·858	29·824	29·957	29·940	29·919	29·943	...
29·750	30·120	30·100	30·110	30·065	29·825	29·630	29·705	29·840	29·970	30·080	29·940	29·928	...
29·852	30·005	30·138	30·120	30·078	29·816	29·771	29·875	29·859	29·993	30·096	30·042	29·970	...
29·939	30·006	30·041	30·103	30·082	29·875	29·799	29·914	29·943	29·925	29·813	30·040	29·957	...
29·832	30·022	30·133	30·214	30·199	30·009	29·870	29·842	29·858	29·938	29·958	29·909	29·982	...
29·990	29·790	29·890	29·940	30·030	29·920	29·73 0	29·900	30·080	29·920	30·180	29·960	29·940	+·200

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. ° ′	Longitude. ° ′	Height, Feet.
Igloolik,	Arctic	1	1822–23	two hourly	69 21	−81 53	0
Fort Hope,	do.	2	1846–47, '53–54	M.P.	66 32	−86 56	10
Hudson's Strait,	do.	1	1836–37	two hourly	various	various	0
Kingua,	do.	1	1882–83	hourly	66 36	−67 14	53
Ananito,	do.	1	1877–78	M.P.	66 20	−66 56	10
Rama,	Labrador	2⅓	1882–84	8 : 2, 8	58 53	−63 15	11
Hebron,	do.	2⅓	do.	do.	58 12	−62 21	49
Nain,	do.	2⅓	do.	do.	56 33	−61 41	14
Okak,	do.	2⅓	do.	do.	57 34	−61 56	25
Do.,	do.	4	1881–84	do.	57 34	−61 56	25
Zoar,	do.	2⅓	1882–84	do.	56 7	−61 22	31
Hoffenthal,	do.	2⅓	do.	do.	55 27	−60 12	25
Chimo,	do.	2	do.	7½ :	59 0	−68 0	126
Fort York,	Dominion of Canada	8	1877–84	M.P.	57 2	−92 20	55
Fort Rae,		1	1882–83	hourly	62 39	−115 44	530
Camden Bay,	do.	1	1853–54	4, 8, N., etc.	70 8	−145 29	0
Point Barrow,	Alaska	2	1852–54	6, 12 : 6, 12	71 21	−156 17	10
Ooglaamie,	do.	2	1881–83	hourly	71 23	−156 40	17
St. Michaels,	do.	11	1874–86	M.P.	63 48	−161 0	30
Port Clarence,	do.	3	1850–54	hourly	65 17	−166 20	0
Port Providence,	do.	¾	1848–49	do.	64 26	−173 0	0
Chamisso,	do.	1	1849–50	do.	66 13	−161 46	0
Nulato, Yukon R.	do.	½	1866–67	9 : 1, 8	60 40	−158 13	100
St. Paul's Island,	do.	5½	1869–76	7 : 2, 9	57 7	−170 18	57
Iliulik,	do.	9	1825–34	7 : 1, 9½	53 52	−166 31	15
Kadiak,	do.	1	1872–73	Noon	57 47	−152 20	20
Sitka,	do.	44	1828–85	M.P.	57 3	−135 19	15
Fort Wrangel,	do.	5/12	1870	7 : 2, 9	56 16	−132 29	55
Fort Tongass,	do.	2½	1868–70	do.	54 46	−130 30	30
Esquimault,	Dominion of Canada.	5	1875–79, 87	7 :	48 26	−123 27	42
New Westminster,		2	1860–61	8½ : 3½	49 13	−122 53	54
St. John (N.F.),	do.	6	1853–59	9½ : 3½	47 35	−52 42	130
St. Pierre,	do.	15	1870–84	7 : 3, 11*	46 47	−56 8	[0]
Sydney,	do.	15	do.	do.	46 8	−60 10	28
Halifax,	do.	15	do.	do.	44 39	−63 36	122
Yarmouth,	do.	15	do.	do.	43 50	−66 2	61
St. John (N.B.),	do.	15	do.	do.	45 17	−66 3	150
Fredericktown,	do.	15	do.	do.	45 57	−66 38	59
Chatham,	do.	15	do.	do.	47 3	−65 29	56
Bathurst,	do.	15	do.	do.	47 39	−65 42	9
Bird Island,	do.	15	do.	do.	47 51	−61 8	85
S. W. P. Anticosti,	do.	15	do.	do.	49 24	−63 16	20
Charlottetown,	do.	15	do.	do.	46 14	−63 10	38
Dalhousie,	do.	15	do.	do.	48 4	−66 22	150
Father Point,	do.	15	do.	do.	48 31	−68 28	20
Quebec,	do.	15	do.	do.	46 48	−71 12	312
Montreal,	do.	15	do.	do.	45 31	−73 33	187
Brockville,	do.	15	do.	do.	44 35	−75 42	273

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·750	29·840	30·030	29·970	29·910	29·930	29·530	29·500	29·730	29·830	29·710	29·590	29·776	...
29·793	30·149	30·174	...	...	29·732	29·891	...	...	29·860	29·931	30·060	...	...
29·914	29·739	29·981	29·943	29·819	29·845	29·833	29·569	29·587	29·791	29·793	29·783	29·800	...
29·558	29·445	29·777	29·863	29·875	29·654	29·701	29·741	29·713	29·739	29·798	29·963	29·736	...
29·591	29·721	29·827	29·985	29·953	29·768	...	...	...	29·725	29·780	29·564	...	...
29·573	29·644	29·750	29·871	29·871	29·681	29·779	29·735	29·650	29·730	29·716	29·829	29·736	...
29·542	29·636	29·730	29·846	29·849	29·679	29·777	29·740	29·621	29·741	29·689	29·796	29·720	...
29·614	29·740	29·769	29·864	29·878	29·735	29·813	29·775	29·691	29·764	29·744	29·826	29·768	...
29·600	29·695	29·760	29·879	29·910	29·714	29·807	29·760	29·668	29·757	29·746	29·833	29·761	...
29·684	29·820	29·769	29·866	29·952	29·750	29·779	29·823	29·701	29·744	29·703	29·804	29·783	...
29·626	29·752	29·776	29·863	29·884	29·744	29·817	29·781	29·716	29·779	29·782	29·819	29·778	...
29·608	29·756	29·769	29·838	29·853	29·756	29·814	29·785	29·716	29·774	29·754	29·807	29·769	...
29·855	29·930	29·960	30·065	29·995	29·885	29·955	29·915	29·770	29·930	29·960	29·970	29·933	...
29·918	29·988	30·024	29·995	29·953	29·898	29·801	29·823	29·870	29·860	29·910	29·930	29·914	−·030
29·582	29·520	29·588	29·331	29·408	29·213	29·244	29·250	29·286	29·176	29·267	29·415	29·357	...
30·120	29·989	29·981	29·866	29·827	29·854	29·836	(29·840)	29·891	29·879	30·301	29·801	29·832	...
30·032	30·053	29·978	29·898	29·944	29·849	29·749	29·832	29·908	29·938	30·111	29·980	29·939	...
29·882	29·953	30·032	29·984	29·961	29·894	29·827	29·777	29·793	29·814	29·842	29·967	29·894	...
29·778	29·859	29·873	29·866	29·777	29·828	29·872	29·822	29·693	29·706	29·794	29·750	29·802	...
30·010	29·777	29·892	29·831	29·702	29·764	29·822	(29·810)	29·756	29·655	29·577	29·705	29·775	...
29·841	29·896	29·738	30·128	29·884	29·738	...	...	...	29·497	29·570	29·697	...	...
30·115	29·585	30·169	29·815	29·914	29·787	29·756	29·703	29·631	29·651	29·500	30·102	29·811	...
30·063	29·986	29·854	29·788	29·782	...	29·948	...	...	...	...	29·688	...	...
29·626	29·609	29·794	29·716	29·697	29·759	29·898	29·926	29·747	29·564	29·622	29·587	29·712	...
29·610	29·567	29·618	29·657	29·684	29·732	29·782	29·789	29·634	29·547	29·534	29·636	29·650	...
29·548	29·504	29·398	29·648	29·647	29·801	29·844	29·783	29·705	29·362	29·576	29·456	29·606	...
29·618	29·678	29·698	29·767	29·816	29·848	29·910	29·848	29·763	29·656	29·575	29·608	29·732	...
...	...	...	...	29·742	29·844	29·855	29·933	29·706	...	...	...	...	...
29·676	29·778	29·847	29·829	29·836	29·960	29·964	30·016	29·966	29·858	29·644	29·742	29·843	...
29·989	29·955	29·907	30·007	29·982	30·004	30·007	29·977	29·992	30·009	29·985	30·044	29·988	...
30·074	30·042	30·022	30·000	29·984	29·962	30·032	30·012	30·029	30·008	29·937	29·928	30·002	...
29·924	29·781	29·690	29·942	29·943	29·934	29·993	29·964	29·971	29·986	29·908	29·842	29·906	...
29·880	29·846	29·836	29·840	29·930	29·904	29·893	29·938	29·982	29·943	29·888	29·842	29·894	...
29·938	29·884	29·886	29·850	29·942	29·934	29·922	29·964	30·015	29·970	29·914	29·876	29·924	...
29·985	29·906	29·862	29·845	29·930	29·918	29·917	29·968	30·020	39·998	29·936	29·923	29·934	...
30·000	29·948	29·894	29·860	29·946	29·927	29·917	29·980	30·033	30·017	29·968	29·966	29·955	...
30·016	29·962	29·896	29·872	29·948	29·900	29·923	29·973	30·036	30·015	29·967	29·957	29·956	...
30·027	29·977	29·925	29·888	29·951	29·919	29·903	29·973	30·031	30·028	29·990	29·974	29·965	...
29·982	29·926	29·890	29·864	29·930	29·890	29·882	29·941	30·000	29·975	29·935	29·933	29·929	...
30·014	29·943	29·915	29·878	29·926	29·860	29·847	29·920	29·980	29·968	29·917	29·911	29·923	...
29·886	29·862	29·854	29·860	29·925	29·898	29·894	29·930	29·960	29·922	29·858	29·847	29·891	...
29·870	29·862	29·824	29·842	29·900	29·848	29·858	29·883	29·928	29·900	29·848	29·862	29·870	...
29·957	29·909	29·876	29·849	29·928	29·906	29·896	29·949	30·005	29·970	29·922	29·908	29·923	...
30·047	29·966	29·904	29·905	29·924	29·875	29·870	29·920	29·997	29·970	29·930	29·952	29·937	...
29·990	29·966	29·928	29·893	29·936	29·878	29·844	29·926	29·987	29·963	29·942	29·975	29·935	...
30·064	30·007	29·966	29·919	29·941	29·890	29·882	29·957	30·021	30·010	30·002	30·020	29·973	...
30·073	30·027	29·955	29·908	29·932	29·893	29·885	29·957	30·023	30·003	30·010	30·033	29·975	...
30·092	30·056	30·005	29·940	29·962	29·923	29·909	29·989	30·047	30·036	30·048	30·050	30·005	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Ottawa, . .	Dominion of	15	1870–84	7 : 3, 11*	45 26	−75 41	250
Rockliffe, . .	Canada.	15	do.	do.	46 12	−77 55	418
Kingston, . .	do.	15	do.	do.	44 14	−76 29	307
Toronto, . .	do.	15	do.	do.	43 29	−79 23	350
Port Dover, . .	do.	15	do.	do.	42 47	−80 13	635
Port Stanley, .	do.	15	do.	do.	42 40	−81 13	592
Woodstock, . .	do.	15	do.	do.	43 8	−80 47	980
Stratford, . .	do.	15	do.	do.	43 23	−81 0	1182
Goderich, . .	do.	15	do.	do.	43 45	−81 43	728
Saugeen, . .	do.	15	do.	do.	44 30	−81 21	656
Parry Sound, .	do.	15	do.	do.	45 19	−80 0	641
Port Arthur, .	do.	15	do.	do.	48 27	−89 12	642
Winnipeg & F. Garry,	do.	14	1874–87	do.	49 53	−97 7	758
Minnedosa, . .	do.	14	do.	$5\frac{1}{3}$:	50 13	−99 48	1665
Qu' Appelle, . .	do.	14	do.	5 :	50 44	−103 42	2115
Medicine Hat, .	do.	14	do.	$4\frac{1}{2}$:	50 1	−110 37	2136
Eastport, . .	Maine	$13\frac{1}{4}$	1871–84	7 : 3, 11*	44 54	−66 59	61
Portland, . .	do.	$13\frac{1}{4}$	do.	do.	43 39	−70 15	45
Burlington, . .	Vermont	$13\frac{1}{4}$	do.	do.	44 29	−73 13	268
Mount Washington,	New Hampshire	12	1873–84	do.	44 16	−71 18	6279
Boston, . .	Massachusetts	$13\frac{1}{4}$	1871–84	do.	42 21	−71 4	142
Thatcher's Island, .	do.	$13\frac{1}{4}$	do.	do.	42 38	−70 34	48
Wood's Holl, .	do.	$13\frac{1}{4}$	do.	do.	41 33	−70 40	34
Newport, . .	Rhode Island	$13\frac{1}{4}$	do.	do.	41 29	−71 19	44
Newhaven, . .	Connecticut	$13\frac{1}{4}$	do.	do.	41 17	−72 57	104
New London, .	do.	$13\frac{1}{4}$	do.	do.	41 21	−72 5	47
Albany, . .	New York	$13\frac{1}{4}$	do.	do.	42 39	−73 45	75
Buffalo, . .	do.	$13\frac{1}{4}$	do.	do.	42 53	−78 53	690
Oswego, . .	do.	$13\frac{1}{4}$	do.	do.	43 29	−76 35	304
Rochester, . .	do.	$13\frac{1}{4}$	do.	do.	43 8	−77 42	621
New York, . .	do.	$13\frac{1}{4}$	do.	do.	40 43	−74 0	164
Atlantic City, .	New Jersey	$13\frac{1}{4}$	do.	do.	39 22	−74 25	13
Cape May, . .	do.	$13\frac{1}{4}$	do.	do.	38 56	−74 58	27
Erie, . . .	Pennsylvania	$13\frac{1}{4}$	do.	do.	42 7	−80 5	681
Philadelphia, .	do.	$13\frac{1}{4}$	do.	do.	39 57	−75 9	92
Pittsburg, . .	do.	$13\frac{1}{4}$	do.	do.	40 32	−80 2	766
Baltimore, . .	Maryland	$13\frac{1}{4}$	do.	do.	39 18	−76 37	45
Washington, .	Dist. Columbia	$13\frac{1}{4}$	do.	do.	38 54	−77 2	106
Morgantown, .	Virginia	$13\frac{1}{4}$	do.	do.	39 40	−79 52	963
Lynchburg, . .	do.	$13\frac{1}{4}$	do.	do.	37 25	−79 9	652
Cape Henry, .	do.	$13\frac{1}{4}$	do.	do.	36 56	−76 0	16
Norfolk, . .	do.	$13\frac{1}{4}$	do.	do.	36 51	−76 17	30
Cape Hatteras, .	North Carolina	$13\frac{1}{4}$	do.	do.	35 14	−75 30	8
Wilmington, . .	do.	$13\frac{1}{4}$	do.	do.	34 14	−77 57	52
Charlotte, . .	do.	$13\frac{1}{4}$	do.	do.	35 13	−80 51	808
Charleston, . .	South Carolina	$13\frac{1}{4}$	do.	do.	32 49	−79 56	52
Savannah, . .	Georgia	$13\frac{1}{4}$	do.	do.	32 5	−81 5	87
Augusta, . .	do.	$13\frac{1}{4}$	do.	do.	33 28	−81 54	183
Atlanta, . .	do.	$13\frac{1}{4}$	do.	do.	33 45	−84 23	1129
Jacksonsville, .	Florida	$13\frac{1}{4}$	do.	do.	30 20	−81 39	43

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·078	30·046	29·971	29·928	29·947	29·898	29·896	29·975	30·034	30·015	30·016	30·037	29·987	...
30·086	30·043	29·992	29·924	29·949	29·880	29·890	29·950	30·022	30·023	30·012	30·024	29·984	...
30·093	30·075	30·000	29·945	29·969	29·943	29·928	29·981	30·046	30·039	30·034	30·044	30·008	...
30·089	30·068	30·010	29·962	29·979	29·944	29·934	29·987	30·045	30·049	30·049	30·051	30·014	...
30·097	30·077	30·005	29·963	29·984	29·947	29·952	29·989	30·045	30·049	30·045	30·053	30·017	...
30·105	30·083	30·013	29·979	29·986	29·949	29·958	29·990	30·043	30·049	30·048	30·056	30·021	...
30·094	30·062	30·007	29·956	29·966	29·926	29·933	29·976	30·037	30·049	30·041	30·050	30·008	...
30·086	30·058	30·011	29·952	29·965	29·924	29·943	29·986	30·037	30·040	30·043	30·046	30·008	...
30·091	30·076	30·026	29·978	29·993	29·952	29·947	29·994	30·044	30·046	30·040	30·054	30·020	...
30·068	30·048	30·011	29·955	29·966	29·926	29·937	29·974	30·016	30·007	30·000	30·001	29·993	...
30·081	30·053	30·008	29·956	29·960	29·923	29·922	29·966	30·020	30·008	30·014	30·024	29·995	...
30·115	30·094	30·052	30·010	29·965	29·890	29·898	29·927	29·952	29·980	30·016	30·068	29·997	...
30·164	30·163	30·109	30·007	29·923	29·856	29·869	29·905	29·919	29·973	30·088	30·139	29·009	...
30·174	30·184	30·100	29·984	29·913	29·846	29·876	29·910	29·927	29·958	30·093	30·131	30·008	...
30·193	30·181	30·080	29·970	29·890	29·836	29·883	29·901	29·935	29·983	30·088	30·143	30·007	...
30·174	30·175	30·082	29·957	29·883	29·806	29·866	29·895	29·947	29·968	30·088	30·140	29·998	+·040
29·937	29·910	29·832	29·795	29·889	29·851	29·839	29·897	29·971	29·942	29·916	29·911	29·891	...
29·996	29·957	29·876	29·843	29·905	29·879	29·866	29·934	30·000	29·988	29·969	29·958	29·931	...
29·804	29·768	29·678	29·636	29·682	29·648	29·650	29·713	29·772	29·773	29·770	29·767	29·722	...
23·400	23·382	23·406	23·514	23·724	23·822	23·868	23·919	23·877	23·727	23·535	23·435	23·634	...
29·920	29·879	29·793	29·756	29·820	29·797	29·797	29·847	29·907	29·905	29·891	29·884	29·850	...
30·026	29·986	29·902	29·855	29·918	29·905	29·903	29·959	30·022	30·018	29·996	29·998	29·957	...
30·040	30·003	29·895	29·873	29·946	29·921	29·910	29·951	30·028	30·020	30·020	30·018	29·977	...
30·035	30·004	29·916	29·874	29·941	29·920	29·918	29·976	30·034	30·030	30·011	30·010	29·972	...
29·993	29·951	29·868	29·817	29·875	29·852	29·846	29·904	29·957	29·951	29·952	29·962	29·911	...
30·061	30·028	29·936	29·890	29·955	29·930	29·926	29·980	30·036	30·032	30·034	30·032	29·987	...
30·056	30·023	29·922	29·876	29·930	29·892	29·878	29·938	30·006	30·011	30·008	30·017	29·963	...
29·328	29·302	29·236	29·211	29·248	29·228	29·237	29·284	29·322	29·312	29·289	29·295	29·274	...
29·744	29·729	29·654	29·621	29·653	29·626	29·625	29·669	29·721	29·724	29·716	29·707	29·682	...
29·399	29·384	29·321	29·296	29·332	29·300	29·308	29·356	29·400	29·396	29·374	29·374	29·353	...
29·960	29·913	29·821	29·774	29·830	29·806	29·805	29·855	29·900	29·916	29·914	29·917	29·868	...
30·122	30·075	29·993	29·949	30·000	29·977	29·965	29·998	30·053	30·075	30·088	30·082	30·031	...
30·110	30·062	29·980	29·931	29·970	29·954	29·955	29·986	30·044	30·067	30·078	30·091	30·019	...
29·350	29·327	29·252	29·230	29·244	29·251	29·253	29·301	29·335	29·331	29·318	29·326	29·293	...
30·093	30·050	29·951	29·901	29·948	29·920	29·913	29·960	30·016	30·034	30·047	30·060	29·991	...
29·293	29·259	29·185	29·144	29·189	29·178	29·191	29·217	29·267	29·267	29·272	29·263	29·227	+·020
30·129	30·094	29·987	29·933	29·966	29·944	29·939	29·980	30·040	30·066	30·081	30·090	30·021	...
30·051	30·000	29·916	29·867	29·913	29·884	29·885	29·918	29·976	29·996	30·018	30·028	29·954	...
29·089	29·038	28·955	28·938	28·978	28·997	29·012	29·039	29·079	29·094	29·071	29·090	29·031	+·040
29·442	29·387	29·320	29·283	29·329	29·311	29·317	29·344	29·399	29·418	29·422	29·420	29·366	...
30·131	30·090	30·010	29·966	30·004	29·978	29·977	30·001	30·045	30·078	30·101	30·113	30·041	...
30·119	30·081	29·988	29·943	29·979	29·960	29·960	29·970	30·031	30·064	30·083	30·101	30·023	...
30·134	30·100	30·030	29·971	30·016	30·003	30·012	30·010	30·047	30·068	30·101	30·109	30·050	...
30·109	30·056	29·984	29·936	29·964	29·960	29·967	29·964	29·995	30·039	30·062	30·096	30·011	...
29·282	29·256	29·170	29·126	29·161	29·184	29·184	29·188	29·236	29·262	29·272	29·284	29·217	...
30·124	30·075	30·011	29·973	29·975	29·973	29·980	29·970	29·998	30·042	30·081	30·114	30·026	...
30·094	30·060	29·991	29·935	29·951	29·950	29·852	29·941	29·981	30·010	30·059	30·092	30·001	...
30·006	29·967	29·890	29·833	29·842	29·847	29·852	29·849	29·879	29·942	29·973	30·000	29·907	...
28·992	28·950	28·885	28·831	28·876	28·876	28·896	28·890	28·915	28·944	28·962	28·970	28·916	...
30·155	30·114	30·054	30·000	29·994	30·012	30·024	29·998	30·002	30·042	30·092	30·134	30·052	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Key West, . .	Florida	13¼	1871–84	7 : 3, 11*	24 34	−81 49	20
Punta Rasa, .	do.	13¼	do.	do.	26 29	−82 1	14
Cedar Keys, . .	do.	13¼	do.	do.	29 8	−83 2	22
St. Mark's, . .	do.	13¼	do.	do.	30 10	−84 12	15
Pensacola, . .	do.	13¼	do.	do.	30 25	−87 13	30
Mobile,. . .	Alabama	13¼	do.	do.	30 41	−88 2	41
Montgomery, .	do.	13¼	do.	do.	32 23	−86 18	219
Vicksburg, . .	Mississippi	13¼	do.	do.	32 22	−90 53	244
Memphis, . .	Tennessee	13¼	do.	do.	35 9	−90 3	321
Knoxville, . .	do.	13¼	do.	do.	35 56	−83 58	986
Nashville, . .	do.	13¼	do.	do.	36 10	−86 47	549
Chattanooga, .	do.	13¼	do.	do.	35 4	−85 15	783
Louisville, . .	Kentucky	13¼	do.	do.	38 15	−85 45	530
Cincinnati, . .	Ohio	13¼	do.	do.	39 6	−84 30	620
Columbus, . .	do.	13¼	do.	do.	39 58	−83 0	805
Toledo,. . .	do.	13¼	do.	do.	41 40	−83 34	651
Cairo, . . .	do.	13¼	do.	do.	37 0	−89 10	377
Springfield, . .	Illinois	13¼	do.	do.	39 48	−89 39	644
Cleveland, . .	do.	13¼	do.	do.	41 30	−81 42	690
Chicago, . .	do.	13¼	do.	do.	41 52	−87 38	661
Indianapolis, .	Indiana	13¼	do.	do.	39 46	−86 10	753
Grand Haven, .	Michigan	13¼	do.	do.	43 5	−86 19	620
Detroit, . .	do.	13¼	do.	do.	42 20	−83 3	661
Port Huron, .	do.	13¼	do.	do.	43 0	−82 26	633
Alpena, . .	do.	13¼	do.	do.	45 5	−83 30	609
Escanaba, . .	do.	13¼	do.	do.	45 48	−87 5	612
Marquette, . .	do.	13¼	dc.	do.	46 34	−87 24	673
La Crosse, . .	Wisconsin	13¼	do.	do.	43 49	−91 15	725
Milwaukie, . .	do.	13¼	do.	do.	43 2	−87 54	697
Duluth, . .	Minnesota	13¼	do.	do.	46 48	−92 6	672
St. Paul's, . .	do.	13¼	do.	do.	44 58	−93 3	801
Pembina, . .	do.	13¼	do.	do.	49 0	−97 5	791
Bismarck, . .	Dakota	13¼	do.	do.	46 47	−100 36	1694
Buford, . .	do.	13¼	do.	do.	48 0	−103 56	1930
Deadwood, . .	do.	13¼	do.	do.	44 23	−103 43	4600
Yankton, . .	do.	13¼	do.	do.	42 54	−97 28	1228
North Platte, .	Nebraska	13¼	do.	do.	41 8	−100 45	2841
Omaha, . .	do.	13¼	do.	do.	41 16	−95 56	1113
Dubuque, . .	Iowa	13¼	do.	do.	42 30	−90 44	665
Des Moines, . .	do.	13¼	do.	do.	41 35	−93 37	849
Leavenworth, .	Kansas	13¼	do.	do.	39 19	−94 57	842
Dodge City, . .	do.	13¼	do.	do.	37 45	−100 0	2517
Keokuk, . .	Iowa	13¼	do.	do.	40 22	−91 26	618
St. Louis, . .	Missouri	13¼	do.	do.	38 38	−90 12	571
Little Rock, . .	Arkansas	13¼	do.	do.	34 45	−92 6	298
Fort Smith, . .	do.	13¼	do.	do.	35 22	−94 24	449
Fort Gibson, .	Indian Territory	13¼	do.	do.	35 50	−95 20	540
Fort Sill, . .	do.	13¼	do.	do.	34 40	−98 23	1200
Shreveport, . .	Louisiana	13¼	do.	do.	32 30	−93 40	227
New Orleans, .	do.	13¼	do.	do.	29 58	−90 4	52

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·108	30·083	30·064	30·014	29·988	30·012	30·032	29·984	29·954	29·955	30·027	30·084	30·025	...
30·160	30·103	30·087	30·030	30·004	30·032	30·051	30·009	29·980	29·998	30·064	30·128	30·054	...
30·160	30·122	30·080	30·026	30·000	30·021	30·042	30·005	30·003	30·034	30·091	30·133	30·060	...
30·177	30·125	30·072	30·014	30·003	30·023	30·038	30·015	30·008	30·047	30·103	30·138	30·064	...
30·186	30·129	30·081	30·022	30·003	30·011	30·027	29·995	30·020	30·066	30·116	30·152	30·067	...
30·145	30·085	30·038	29·984	29·970	29·975	30·003	29·966	29·986	30·039	30·099	30·116	30·034	...
29·968	29·916	29·849	29·781	29·784	29·796	29·814	29·786	29·821	29·871	29·918	29·950	29·855	...
29·930	29·875	29·811	29·749	29·756	29·772	29·789	29·777	29·809	29·848	29·902	29·917	29·828	...
29·851	29·793	29·722	29·648	29·656	29·660	29·700	29·692	29·736	29·782	29·808	29·833	29·740	...
29·130	29·096	29·018	28·971	29·004	29·016	29·039	29·015	29·078	29·107	29·108	29·123	29·061	...
29·638	29·576	29·514	29·450	29·471	29·475	29·503	29·493	29·540	29·571	29·586	29·615	29·535	...
29·347	29·317	29·232	29·173	29·202	29·220	29·239	29·234	29·283	29·308	29·322	39·340	29·268	...
29·579	29·544	29·478	29·420	29·441	29·432	29·460	29·468	29·516	29·541	29·557	29·579	29·501	+ ·030
29·474	29·418	29·380	29·326	29·357	29·339	29·353	29·375	29·417	29·463	29·464	29·477	29·406	...
29·255	29·220	29·172	29·116	29·146	29·129	29·154	29·178	29·216	29·234	29·238	29·237	29·190	...
29·391	29·353	29·281	29·253	29·272	29·266	29·290	29·322	29·351	29·356	29·360	29·365	29·322	...
29·763	29·731	29·661	29·587	29·608	29·600	29·644	29·632	29·677	29·714	29·747	29·768	29·678	...
29·460	29·414	29·355	29·290	29·315	29·295	29·346	29·358	29·390	29·405	29·424	29·435	29·374	...
29·354	29·324	29·263	29·231	29·265	29·247	29·252	29·292	29·335	29·334	29·331	29·330	29·296	...
29·363	29·341	29·289	29·248	29·256	29·246	29·279	29·297	29·322	29·331	29·325	29·350	29·304	...
29·300	29·257	29·198	29·147	29·183	29·172	29·210	29·222	29·258	29·276	29·277	29·291	29·233	...
29·378	29·367	29·319	29·290	29·306	29·278	29·312	29·336	29·362	29·357	29·360	29·367	29·336	...
29·364	29·341	29·286	29·254	29·285	29·256	29·279	29·320	29·350	29·343	29·341	29·342	29·311	...
29·378	29·351	29·299	29·270	29·300	29·268	29·283	29·328	29·358	29·354	29·352	29·350	29·324	...
29·358	29·358	29·329	29·304	29·316	29·290	29·298	29·330	29·349	29·329	29·330	29·330	29·327	...
29·346	29·351	29·327	29·313	29·300	29·260	29·293	29·320	29·329	29·322	29·328	29·329	29·317	...
29·284	29·281	29·247	29·256	29·248	29·200	29·221	29·261	29·268	29·252	29·258	29·255	29·253	...
29·304	29·264	29·246	29·168	29·187	29·170	29·204	29·242	29·230	29·252	29·280	29·305	29·238	...
29·302	29·276	29·250	29·194	29·225	29·197	29·242	29·266	29·282	29·279	29·284	29·290	29·257	...
29·334	29·319	29·291	29·251	29·235	29·202	29·220	29·253	29·254	29·257	29·281	29·319	29·267	...
29·209	29·180	29·154	29·083	29·088	29·061	29·112	29·131	29·140	29·143	29·172	29·200	29·140	...
29·230	29·212	29·187	29·136	29·075	29·014	29·048	29·091	29·088	29·121	29·184	29·206	29·133	...
28·180	28·187	28·183	28·136	28·099	28·073	28·132	28·146	28·162	28·149	28·192	28·206	28·154	...
28·007	27·997	27·886	27·958	27·913	27·879	27·922	27·941	27·955	27·943	27·990	28·004	27·956	...
25·252	25·257	25·278	25·286	25·326	25·339	25·420	25·413	25·416	25·386	25·354	25·277	25·334	...
28·800	28·771	28·720	28·650	28·624	28·614	28·675	28·700	28·707	28·721	28·755	28·788	28·710	...
27·079	27·057	27·022	26·997	27·008	27·024	27·076	27·089	27·091	27·096	27·115	27·105	27·063	...
28·954	28·915	28·857	28·781	28·788	28·786	28·842	28·853	28·872	28·891	28·923	28·948	28·868	...
29·376	29·346	29·296	29·242	29·243	29·220	29·266	29·293	29·316	29·337	29·345	29·378	29·305	...
29·235	29·190	29·122	29·056	29·061	29·067	29·101	29·112	29·156	29·154	29·188	29·215	29·138	...
29·255	29·191	29·125	29·053	29·049	29·048	29·107	29·116	29·149	29·160	29·203	29·237	29·141	...
27·453	27·425	27·360	27·303	27·320	27·323	27·402	27·419	27·432	27·424	27·454	27·420	27·403	...
29·456	29·414	29·354	29·281	29·282	29·273	29·325	29·334	29·367	29·391	29·427	29·443	29·362	...
29·567	29·510	29·454	29·376	29·396	29·389	29·430	29·441	29·478	29·496	29·535	29·549	29·468	...
29·840	29·795	29·733	29·646	29·653	29·665	29·700	29·994	29·740	29·767	29·813	29·830	29·740	...
29·674	29·633	29·560	29·472	29·476	29·492	29·536	29·530	29·576	29·594	29·650	29·666	29·572	...
29·589	29·534	29·454	29·361	29·346	29·371	29·420	29·432	29·464	29·504	29·524	29·558	29·463	...
28·888	28·842	28·770	28·705	28·690	28·702	28·750	28·752	28·786	28·810	28·863	28·852	28·785	...
29·945	29·874	29·816	29·734	29·760	29·768	29·790	29·778	29·804	29·853	29·900	29·923	29·820	...
30·106	30·056	30·003	29·958	29·940	29·950	29·977	29·940	29·955	30·017	30·055	30·085	30·004	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Corsicana, . .	Texas	13¼	1871–84	7 : 3, 11 *	32 5	–96 30	445
Denison, . .	do.	13¼	do.	do.	33 48	–96 32	767
Galveston, . .	do.	13¼	do.	do.	29 18	–94 47	40
Indianola, . .	do.	13¼	do.	do.	28 32	–96 31	26
Brownsville, . .	do.	13¼	do.	do.	25 53	–97 26	59
Rio Grande City, .	do.	13¼	do.	do.	26 22	–98 48	230
Laredo, . .	do.	13¼	do.	do.	27 31	–99 30	460
Eagle Pass, . .	do.	13¼	do.	do.	28 44	–100 29	780
San Antonio, .	do.	13¼	do.	do.	29 25	–98 25	673
Concho, . .	do.	13¼	do.	do.	31 25	–100 24	1900
Fort Elliott, .	do.	13¼	do.	do.	35 30	–100 21	2650
Fort Stockton, .	do.	13¼	do.	do.	30 53	–102 53	3010
El Paso, . .	do.	13¼	1872–83	do.	31 47	–106 30	3764
Fort Thomas, .	Mexico (New)	13¼	do.	do.	33 4	–110 2	2710
Santa Fé, . .	do.	12	do.	do.	35 41	–105 57	7106
Tucson, . .	Arizona	13¼	do.	do.	32 14	–110 53	2369
Yuma, . . .	do.	11	1874–84	do.	32 45	–114 36	141
Prescott, . .	do.	11	do.	do.	34 33	–112 28	5340
Salt Lake City, .	Utah	11	do.	do.	40 46	–111 54	4348
Denver, . .	Colorado	11	do.	do.	39 45	–105 0	5294
Pike's Peak, . .	do.	11	do.	do.	38 50	–105 2	14134
Cheyenne, . .	Wyoming	11	do.	do.	41 8	–104 48	6105
Fort Custer, . .	Montana	11	do.	do.	45 42	–107 34	3040
Fort Benton, .	do.	11	do.	do.	47 50	–110 40	2694
Assinaboine, .	do.	11	do.	do.	48 32	–109 42	2710
Lewiston, . .	Idaho	11	do.	do.	46 8	–117 5	780
Boise City, . .	do.	11	do.	do.	43 37	–116 8	2750
Olympia, . .	Washington	13¼	1871–84	do.	47 3	–122 53	36
Dayton, . .	do.	13¼	do.	do.	46 19	–117 56	1617
Portland, . .	Oregon	13¼	do.	do.	45 32	–122 43	67
Umatilla, . .	do.	13¼	do.	do.	45 55	–119 20	340
Roseburg, . .	do.	13¼	do.	do.	43 13	–123 20	511
Winnemucca, .	Nevada	13¼	do.	do.	40 59	–117 43	4327
C. Mendocino, .	California	13¼	do.	4 :	40 26	–124 24	637
Red Bluff, . .	do.	13¼	do.	7 : 3, 11	40 10	–122 15	332
Sacramento, . .	do.	13¼	do.	do.	38 35	–121 30	65
San Francisco, .	do.	13¼	do.	do.	37 48	–122 26	60
Visalia, . .	do.	13¼	do.	do.	36 20	–119 17	348
Los Angeles, .	do.	13¼	do.	do.	34 3	–118 15	371
San Diego, . .	do.	13¼	do.	do.	32 43	–117 10	67
Mazatlan, . .	Mexico	5	1880–84	do.	23 11	–106 17	249
Mexico, . .	do.	9	1877–85	do.	19 26	–99 0	7490
Puebla, . .	do.	8	1878–85	do.	19 2	–98 3	7113
Leon, . . .	do.	4⅓	1882–86	M.P.	21 7	–101 36	5902
Vera Cruz, . .	do.	4	?	?	19 12	–96 9	26
do. . .	do.	3	1863–65	?	19 11	–96 9	100
Cordova, . .	do.	5	1861–65	9 : 3	18 51	–96 54	2879
Quatimala, . .	Guatemala	3	1880–82	7 : 2, 9	14 38	–90 31	4856
Belize, . . .	Brit. Honduras	4	1865–69	10 : 4	17 30	–88 18	27
Bluefields, . .	Cent. America	1½	1864–65	6½ :	12 8	–83 43	20

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·663	29·593	29·528	29·470	29·455	29·485	29·525	29·495	29·538	29·586	29·638	29·627	29·550	...
29·320	29·284	29·213	29·140	29·157	29·171	29·205	29·206	29·229	29·260	29·311	29·328	29·235	...
30·116	30·059	29·996	29·934	29·926	29·946	29·977	29·949	29·960	30·017	30·064	30·092	30·003	...
30·114	30·084	30·008	29·948	29·941	29·958	29·998	29·972	29·980	30·032	30·070	30·090	30·016	...
30·056	30·019	29·943	29·869	29·860	29·886	29·928	29·891	29·908	29·958	30·009	30·030	29·947	...
29·915	29·868	29·786	29·714	29·692	29·727	29·770	29·741	29·766	29·845	29·906	29·900	29·803	...
29·685	29·631	29·527	29·469	29·451	29·465	29·501	29·502	29·531	29·602	29·639	29·672	29·556	...
29·328	29·292	29·220	29·140	29·130	29·142	29·165	29·174	29·204	29·261	29·317	29·314	29·224	...
29·449	29·392	29·321	29·257	29·252	29·271	29·306	29·299	29·309	29·361	29·415	29·451	29·340	...
28·178	28·136	28·098	28·028	28·024	28·045	28·072	28·080	28·109	28·145	28·182	28·185	28·107	...
27·268	27·252	27·218	27·177	27·165	27·173	27·252	27·257	27·282	27·280	27·300	27·276	27·241	...
27·030	27·006	26·956	26·925	26·908	26·918	26·965	26·962	26·998	27·024	27·040	27·032	26·980	...
26·284	26·232	26·216	26·194	26·162	26·180	26·258	26·257	26·277	26·278	26·308	26·300	26·246	...
27·283	27·232	27·207	27·150	27·124	27·137	27·158	27·184	27·195	27·223	27·273	27·311	27·206	...
23·189	23·156	23·160	23·172	23·204	23·280	23·366	23·349	23·337	23·291	23·248	23·208	23·247	...
27·628	27·572	27·551	27·537	27·484	27·493	27·527	27·521	27·532	27·567	27·628	27·631	27·526	...
29·947	29·896	29·827	29·765	29·683	29·637	29·645	29·660	29·678	29·773	29·879	29·903	29·774	...
24·744	24·726	24·716	24·671	24·703	24·730	24·789	24·788	24·790	24·766	24·770	24·726	24·743	...
25·673	25·668	25·602	25·568	25·552	25·585	25·622	25·624	25·641	25·664	25·719	25·701	25·635	...
24·698	24·682	24·690	24·707	24·703	24·763	24·846	24·848	24·831	24·800	24·778	24·718	24·755	...
17·501	17·511	17·542	17·622	17·769	17·943	18·068	18·070	17·960	17·811	17·670	17·563	17·753	...
23·916	23·903	23·918	23·939	23·975	24·057	24·130	24·141	24·115	24·057	24·003	23·941	24·008	...
26·778	26·755	26·748	26·776	26·753	26·751	26·800	26·825	26·841	26·826	26·856	26·826	26·795	...
27·220	27·198	29·168	27·156	27·156	27·126	27·156	27·166	27·213	27·209	27·227	27·214	27·156	...
27·160	27·128	27·110	27·103	27·124	27·086	27·134	27·144	27·154	27·136	27·165	27·150	27·114	...
29·329	29·271	29·183	29·186	29·134	29·100	29·098	29·101	29·144	29·226	29·341	29·350	29·205	...
27·252	27·210	27·180	27·124	27·112	27·097	27·126	27·118	27·157	27·228	27·276	27·250	27·175	...
29·986	29·955	29·928	29·974	29·989	29·988	29·987	29·968	29·983	29·996	30·021	29·993	29·981	...
28·335	28·264	28·240	28·257	28·238	28·216	28·225	28·233	28·256	28·264	28·345	28·358	28·270	...
30·013	29·977	29·940	29·975	29·978	29·976	29·966	29·946	29·958	29·996	30·035	30·013	29·981	...
29·778	29·726	29·686	29·639	29·636	29·592	29·598	29·594	29·638	29·714	29·816	29·782	29·683	...
29·549	29·517	29·482	29·479	29·499	29·496	29·483	29·464	29·479	29·520	29·570	29·537	29·506	...
25·670	25·650	25·620	25·575	25·588	25·568	25·626	25·608	25·639	25·675	25·716	25·688	25·635	...
29·395	29·380	29·363	29·343	29·318	29·296	29·297	29·286	29·302	29·353	29·416	29·410	29·347	...
29·770	29·713	29·668	29·640	29·581	29·503	29·499	29·488	29·528	29·642	29·728	29·742	29·625	+·020
30·046	30·030	29·978	29·941	29·876	29·817	29·797	29·794	29·827	29·916	30·024	30·030	29·923	...
30·052	30·031	30·001	29·984	29·932	29·896	29·885	29·876	29·887	29·956	30·036	30·034	29·964	...
29·760	29·725	29·680	29·633	29·568	29·486	29·478	29·474	29·535	29·632	29·734	29·746	29·621	...
29·730	29·709	29·687	29·661	29·614	29·581	29·586	29·562	29·566	29·621	29·688	29·707	29·643	...
30·031	30·020	29·994	29·961	29·906	29·880	29·884	29·855	29·855	29·916	29·980	30·001	29·940	...
29·758	29·767	29·746	29·718	29·669	29·660	29·707	29·672	29·641	29·655	29·710	29·745	29·704	...
23·103	23·091	23·091	23·044	23·075	23·087	23·115	23·099	23·095	23·103	23·115	23·107	23·094	...
23·371	23·355	23·363	23·347	23·355	23·359	23·390	23·375	23·355	23·355	23·371	23·375	23·364	...
24·348	24·324	24·313	24·284	24·300	24·322	24·350	24·340	24·328	24·333	24·356	24·353	24·329	...
30·103	30·040	29·965	29·961	29·894	29·894	29·969	29·989	29·973	29·981	30·071	30·083	29·993	...
30·020	29·990	29·938	29·914	29·867	29·847	29·926	29·906	29·831	29·847	29·990	29·997	29·922	...
28·182	28·126	28·099	28·075	28·063	28·087	28·135	28·130	28·118	28·126	28·178	28·197	28·126	...
25·256	25·292	25·273	25·269	25·225	25·252	25·284	25·256	25·241	25·217	25·252	25·264	25·258	...
30·052	30·052	30·000	29·989	29·918	29·945	29·989	29·981	29·938	29·930	30·032	30·052	29·989	...
30·000	29·970	30·000	29·960	29·910	29·925	29·930	29·930	29·905	29·905	30·920	30·970	29·944	+·020

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	Latitude. ′	Longitude. °	Longitude. ′	Height, Feet.
San José, . .	Cent. America	11	1868–78	7 : 2, 9	9	56	−84	0	3756
Port of Anapala, .	do.	$\frac{1}{4}$	1857	do.	13	8	−87	34	0
Colon, . . .	do.	5	1881–85	7, 11 : 7	9	22	−79	55	164
Gamboa, . .	do.	5	1882–84, '85	do.	9	10	−79	43	98
Naos, . . .	do.	5	1881–85	do.	8	57	−79	31	46
Bermuda, . .	West Indies	15	1870–84	9 : 3	32	17	−64	14	120
Nassau, . .	do.	14	1871–84	9 : 3	25	5	−77	21	44
Havanna, . .	do.	19	1858–76	M.P.	23	8	−82	23	62
Navassa, . .	do.	$2\frac{1}{2}$	1880–82	do.	19	25	−75	3	77
St. Iago, . .	do.	$2\frac{1}{2}$	1880–83	do.	19	55	−75	50	21
Kingston, . .	do.	6	1880–86	7 : 3, 11	18	1	−76	48	10
Cinchona Pln., .	do.	$2\frac{1}{2}$	1882–85	7 : 3	18	5	−76	44	4850
Up Park Camp, .	do.	6	1853–59	$9\frac{1}{2}$: $3\frac{1}{2}$	18	0	−76	56	225
St. Juan de Porto Rico, . .	do.	10	1877–86	M.P.	18	30	−66	10	82
La Pointe-à-Pitre,	do.	7	1878–84	10 : 4	16	14	−61	31	13
St. Croix, Christianstadt, . .	do.	5	1879, '82–85	8 : 2, 9	17	45	−64	42	82
Barbadoes, . .	do.	15	1870–84	9 : 3	13	4	−59	40	25
St. Ann's, Trinidad,	do.	18	1862–80	$9\frac{1}{2}$: $3\frac{1}{2}$	10	30	−61	20	130
Caledonia Bay, .	Colombia	$\frac{1}{6}$	1854	3, 9 : 3, 9	8	54	−77	45	0
Carthagena, . .	do.	$\frac{1}{4}$	do.	do.	10	22	−75	32	0
Panama, . .	do.	1	...	M.P.	...		...		10
Puerto Berrio, .	do.	4	1880–84	7 :	6	32	−74	28	542
Medillin, . .	do.	5	1875–79	$7\frac{2}{3}$: $4\frac{2}{3}$	6	10	−75	45	4951
Bogata, . .	do.	2	1848–50	9 : 3	4	35	−74	14	8727
Do. . .	do.	$4\frac{1}{2}$	1880–84	$7\frac{3}{4}$:	4	36	−74	14	8655
Quito, . . .	Ecuador	$1\frac{1}{3}$	1878–80	6 : 2, 10	−0	14	−78	45	9350
Antisana, . .	do.	1	1845–46	10 : 4	−0	21	−78	6	13,320
Carraccas, . .	Venezuela	3	1868–70	10 : 4	10	30	−66	55	3043
George Town, .	Brit. Guiana	11	1846–56	8, 9, 10 : 2, 3, 4	6	50	−58	8	10
Paramaribo, . .	Surinam	15	1870–84	8 : 2	5	50	−55	13	6
Catherina Sophia, .	do.	2	1858–59	6 : 2, 6	5	48	−56	47	50
Cayenne, . .	French Guiana	6	1845–52	9, N. : 3, 9	4	56	−55	39	7
Manaos, . .	Brazil	$\frac{5}{6}$	?	9 : 3	3	8	−60	0	121
Para, . . .	do.	3	1848, etc.	?	−1	30	−48	24	0
Porto do Maranhao,	do.	$1\frac{1}{2}$	1886–87	M.P.	−2	30	−44	0	14
Ceara, . . .	do.	1	1860	?	−3	43	−38	35	[0]
Pernambuco, .	do.	8	1876–84	7 : 1	−8	4	−34	52	11
Colonia Isabel, .	do.	$6\frac{1}{2}$	1876–84	M.P.	−8	45	−35	42	751
Victoria, . .	do.	7	1876–84	do.	−8	9	−35	27	528
Bahia, . . .	do.	$5\frac{1}{2}$	1881–88	do.	−12	58	−38	30	330
St. Bento das Lagos,	do.	$3\frac{1}{2}$	1881–84	6 : 2, 8	−12	13	−38	40	98
San Antonia da Palmeira, . .	do.	$1\frac{1}{2}$	1879–80	7 : 1, 9	−27	54	−53	26	1896
Queluz, . .	do.	2	1882–83	M.P.	−22	36	−44	38	3223
Itabira, . .	do.	1	1882–83	do.	−19	40	−43	5	2733
Rio Janeiro, . .	do.	34	1851–84	4, 7, 10 : 1, 7, 10	−22	57	−43	7	224
San Paulo, . .	do.	$4\frac{1}{2}$	1879–83	M.P.	−23	33	−46	37	2393
Passo Fundo, .	do.	1	1880–81	do.	−28	13	−52	12	2060

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
26·308	26·316	26·316	26·320	26·308	26·312	26·312	26·308	26·304	26·292	26·292	26·300	26·307	...
...	...	...	...	29·887	29·860	29·893	...	...	...	...	...	...	...
29·804	29·840	29·853	29·790	29·776	29·768	29·774	29·772	29·772	29·776	29·772	29·786	29·789	–·110
29·882	29·898	29·904	29·888	29·869	29·869	29·870	29·858	29·862	29·880	29·858	29·873	29·876	...
29·890	29·902	29·914	29·885	29·872	29·884	29·868	29·880	29·876	29·868	29·848	29·860	29·879	...
30·172	30·123	30·120	30·070	30·036	30·067	30·078	30·055	38·014	30·000	30·066	30·130	30·075	...
30·168	30·110	30·123	30·067	30·036	30·060	30·080	30·054	30·014	30·000	30·065	30·136	30·076	...
30·062	30·042	29·988	29·964	29·908	29·955	29·990	29·946	29·911	29·904	29·975	29·035	29·973	...
30·016	29·967	29·967	29·988	29·910	29·950	29·990	29·952	29·920	29·908	29·922	29·973	29·957	+·070
30·085	30·100	30·060	30·043	29·980	30·050	30·070	30·010	29·975	29·973	30·013	30·055	30·034	+·030
30·076	30·055	30·043	30·007	29·984	30·011	30·045	29·982	29·961	29·947	29·975	30·000	30·007	...
25·305	25·285	25·278	25·258	25·256	25·285	25·312	25·272	25·256	25·221	25·225	25·262	25·268	...
30·100	30·071	30·057	30·038	29·998	30·027	30·046	30·024	30·000	29·990	30·003	30·055	30·030	+·040
29·936	29·980	29·980	29·965	29·934	29·906	29·957	29·961	29·916	29·888	29·850	29·875	29·929	...
30·056	30·056	30·044	30·024	30·004	30·044	30·044	29·997	29·989	29·953	29·957	30·008	30·015	...
30·048	30·028	30·024	29·981	29·970	30·020	30·042	29·977	29·953	29·906	29·910	29·957	29·985	...
30·028	30·045	30·038	30·024	30·024	30·043	30·036	30·010	29·996	29·972	29·965	29·992	30·014	...
29·857	29·871	29·853	29·848	29·832	29·869	29·864	29·838	29·822	29·799	29·789	29·817	29·838	...
...	29·922	29·858	...	...	...	...	...	...	...	...	...	...	...
...	...	...	29·848	29·856	29·843	...	...	...	...	...	...	...	...
29·924	29·947	29·924	29·941	29·934	29·959	29·995	29·965	29·995	29·950	29·955	29·962	29·954	...
29·390	29·415	29·432	29·442	29·433	29·430	29·410	29·420	29·412	29·418	29·393	29·385	29·415	...
25·158	25·162	25·166	25·170	25·170	25·185	25·174	25·185	25·178	25·178	25·154	25·158	25·170	...
22·048	22·060	22·061	22·079	22·060	22·060	22·058	22·062	22·076	22·068	22·049	22·034	22·060	...
22·010	22·040	22·050	22·050	22·048	22·063	22·052	22·052	22·046	22·032	22·003	22·017	22·039	...
21·586	21·550	21·566	21·552	21·560	21·564	21·560	21·556	21·552	21·571	21·579	21·575	21·564	...
18·560	18·556	18·576	18·572	18·600	18·603	18·600	18·587	18·570	18·570	18·562	18·550	18·576	...
26·937	26·930	26·926	26·922	26·918	26·949	26·945	26·930	26·914	26·886	26·886	26·938	26·924	...
29·943	29·966	29·957	29·945	29·933	29·962	29·966	29·954	29·938	29·914	29·877	29·910	29·939	+·040
29·923	29·946	29·948	29·941	29·939	29·960	29·964	29·956	29·946	29·914	29·900	29·915	29·938	–·040
29·890	29·900	29·880	29·880	29·870	29·895	29·915	29·890	29·890	29·855	29·870	29·870	29·884	...
29·903	29·932	29·924	29·925	29·916	29·946	29·957	29·961	29·944	29·917	29·880	29·889	29·924	...
29·827	29·823	29·835	29·851	29·847	29·886	29·867	(29·857)	(29·844)	29·808	29·784	29·737	29·831	...
29·880	29·920	29·940	29·940	29·940	29·960	29·970	29·980	29·970	29·935	29·900	29·890	29·935	...
(29·880)	29·914	29·928	29·932	29·950	29·965	30·020	29·970	(29·930)	(29·900)	29·855	29·823	29·922	...
29·923	29·963	29·955	29·931	29·951	29·975	29·998	29·975	30·018	29·791	29·923	29·919	29·959	+·100
29·926	29·914	29·930	29·926	29·956	30·016	30·048	30·052	30·034	29·977	29·922	29·922	29·969	...
29·158	29·154	29·162	29·170	29·201	29·276	29·300	29·300	29·276	29·209	29·146	29·154	29·211	...
29·375	29·363	29·375	29·383	29·414	29·481	29·504	29·500	29·492	29·430	29·371	29·375	29·422	...
29·626	29·606	29·620	29·630	29·696	29·770	29·808	29·817	29·768	29·674	29·620	29·630	29·692	...
29·878	29·878	29·855	29·918	29·957	29·993	30·075	30·095	30·012	29·950	29·875	29·865	29·943	...
27·886	27·881	27·932	28·060	28·114	28·144	28·123	28·110	28·103	28·028	27·898	27·878	28·013	...
26·693	26·693	26·731	26·752	26·782	26·850	26·827	26·850	26·817	26·715	26·662	26·664	26·753	...
...	...	27·192	...	27·276	27·319	27·343	27·343	27·260	27·256	27·162	27·130	...	...
29·701	29·715	29·743	29·808	29·866	29·934	30·028	29·933	29·882	29·793	29·747	29·707	29·821	...
27·514	27·524	27·571	27·626	27·654	27·729	27·737	27·741	27·678	27·603	27·536	27·524	27·619	...
27·830	27·865	27·913	27·942	27·909	28·019	27·999	28·062	27·956	27·850	27·889	27·869	27·925	+·052

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Pelotas, . .	Brazil	3	1875–77	6 : 2, 10	−31 47	−52 19	20
Rio Grande do Sul,	do.	6	1877–82	M.P.	−32 0	−52 15	54
Lima, . . .	Peru	1	1869	9, N. : 6, M.	−12 3	−78 0	499
Do. . . .	do.	?	?	do.	−12 3	−78 0	499
Arica, . . .	Bolivia	1½	1854–55	6, N. : 5, 9	−18 25	−70 22	10
Iquique, . .	do.	3	1883–86	M.P.	−20 12	−70 11	30
Punta Caldera, .	Chile	5	1870–71, '83–86	do.	−27 5	−70 50	82
Copiapo, . .	do.	5	1868–72	do.	−27 22	−70 23	1296
Serena, . .	do.	6	1852–54, '70–72	do.	−29 55	−71 17	59
Coquimbo, . .	do.	6	1870–72, '83–86	do.	−29 56	−71 21	74
Valparaiso, . .	do.	7	1869–72, '83–86	do.	−33 1	−71 40	151
Santiago de Chile,	do.	21	1860–81	7 : 2, 10	−33 27	−70 41	1703
Talca, . . .	do.	3	1869, '71–72	do.	−35 26	−71 46	344
Valdivia, . .	do.	4	1869–72	do.	−39 49	−73 17	43
Puerto Mont, .	do.	3	1870–72	do.	−41 30	−72 57	20
Ancud, . .	do.	2	1866–68	8, N. : 4, 8	−41 51	−74 1	134
San Jorge, . .	Uruguay	5	1882–87	9½ : 3½	−32 43	−56 8	400
Matanzas, . .	do.	7	1877–83	7 : 2, 9	−34 44	−58 33	69
Monte Video, .	do.	10	1843–52	S.-R. : 2, S.-S.	−34 54	−56 13	39
Colonia, . .	do.	1	1883	7 : 2, 7	−34 50	−58 37	109
Salta, . . .	Argentine Rep.	7	1873–76, '79–82	7 : 2, 9	−24 46	−65 24	4030
Assuncion, . .	do.	1	1874	9 : 9	−25 16	−57 40	322
Villa Formosa, .	do.	4½	1879–83	do.	−26 13	−58 10	328
Corrientes, . .	do.	6	1874–80	do.	−27 28	−58 49	280
Goya, . . .	do.	11	1876–86	7 : 2, 9	−29 9	−59 15	209
Tucuman, . .	do.	6	1874, '77, '80–82, '85	do.	−26 51	−65 12	1522
Rioja, . . .	do.,	2½	1875–78	do.	−29 20	−67 15	1773
Saladillo, . .	do.	4¼	1878–82	do.	−29 30	−60 33	1773
Mendosa, . .	do.	5	1875–80	do.	−32 53	−68 49	2641
San Luis, . .	do.	3½	1874–77	do.	−33 19	−66 20	2490
Cordova, . .	do.	12	1872–76, '78–82, '84–85	do.	−31 25	−64 11	1460
Concordia, . .	do.	3	1875–78	do.	−31 25	−58 4	200
Rosario, . .	do.	6	1875–80	do.	−32 57	−60 38	128
Villa Hermandaria,	do.	8	1877–82, '83–84	do.	−31 15	−59 40	190
Parana, . .	do.	8	1875–82	do.	−31 44	−61 1	256
Buenos Ayres, .	do.	21	1856–76	do.	−34 39	−58 23	12
Do. . .	do.	8	1870–77	8 : 2, 8	−34 39	−58 23	50
San Antonia de Areco,	do.	3	1879–82	7 : 2, 9	−34 13	−59 30	121
Salado, . .	do.	4½	1878–82	7 : 2, 9	−35 44	−59 5	49
Dolores, . .	do.	4½	1878–82	7 : 2, 9	−36 19	−58 20	33
Tandil, . . .	do.	6	1876–82	do.	−37 17	−59 0	651
Bahia Blanca, .	do.	14	1870–83	do.	−38 45	−62 11	49
Do. . .	do.	24	1860–83	do.	−38 45	−62 11	49
Punta Arenas, .	Patagonia	2	1871–72	do.	−53 10	−70 52	33
Cape Pembroke, .	do.	9	1859–68	4, 9 : 3, 8	−51 41	−57 47	0
Ushuaia, . .	do.	7½	1876–82	7 : 2, 9	−54 53	−68 10	98
Orange Bay, .	do.	1	1882–83	hourly	−55 31	−68 5	39
{Port Stanley, .	Falkland Is.	1	1882–83	8 : 2, 8	−51 42	−57 48	22
{Stanley, . .	do.	3	1875–77	9 :	−51 41	−57 51	22
The above two, .	do.	4	do.	various	−51 42	−57 50	22
South Georgia, .	South Atlantic	1	1882–83	hourly	−54 31	−36 5	30

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·859	29·867	29·988	30·012	30·107	30·237	30·190	30·217	30·123	30·036	29·953	29·835	30·032	...
29·892	29·936	29·985	30·013	30·042	30·107	30·095	30·124	30·030	30·135	30·040	29·958	30·002	...
29·314	29·331	29·363	29·361	29·402	29·414	29·464	29·495	29·488	29·484	29·465	29·421	29·417	...
29·873	29·884	29·914	29·917	29·966	29·982	30·027	30·057	30·051	30·046	30·033	29·986	29·978	...
29·922	29·957	29·945	29·977	29·981	30·044	30·020	30·048	30·024	30·020	29·997	29·969	29·993	...
29·926	29·915	29·926	29·973	29·985	30·035	30·030	29·986	30·024	30·020	29·984	29·940	29·978	+·040
29·856	29·851	29·877	29·910	29·938	30·965	30·950	29·948	30·958	30·942	29·908	29·882	29·915	...
28·628	28·650	28·655	28·700	28·736	28·747	28·750	28·739	28·732	28·713	28·682	28·658	28·668	...
29·864	29·870	29·875	29·926	29·954	29·970	29·973	30·008	29·984	29·964	29·932	29·880	29·933	...
29·922	29·913	29·918	29·953	29·985	30·015	30·013	30·010	30·017	29·984	29·948	29·923	29·967	...
29·806	29·813	29·830	29·856	29·887	29·935	29·932	29·924	29·914	29·903	29·843	29·820	29·872	...
28·169	28·174	28·192	28·229	28·255	28·266	28·278	28·300	28·274	28·254	28·221	28·186	28·233	...
29·583	29·583	29·626	29·673	29·697	29·728	29·756	29·728	29·748	29·685	29·657	29·634	29·675	−·040
29·941	29·933	29·910	30·008	29·973	29·996	29·970	29·992	30·047	29·996	29·984	29·941	29·974	−·020
29·922	29·914	29·860	29·957	29·922	29·945	29·938	29·945	30·048	29·970	30·024	29·957	29·945	...
29·869	29·867	29·756	29·748	29·705	29·741	29·808	29·792	29·878	29·914	29·804	29·815	29·808	...
29·481	29·505	29·542	29·599	29·665	29·656	29·724	29·644	29·660	29·612	29·522	29·478	29·591	...
29·823	29·864	29·903	29·960	29·972	30·024	30·022	30·060	30·045	29·960	29·876	29·810	29·943	...
29·881	29·916	29·964	30·005	29·999	30·030	30·014	30·089	30·052	29·980	29·940	29·900	29·978	+·040
29·774	29·740	29·730	29·838	29·880	29·810	29·916	29·985	29·944	29·834	29·732	29·707	29·824	...
26·008	26·026	26·034	26·067	26·070	26·119	26·115	26·087	26·079	26·056	26·016	26·000	26·056	...
29·508	29·564	29·684	29·817	29·837	29·843	29·908	29·884	29·703	29·666	29·603	29·556	29·714	...
29·570	29·627	29·647	29·723	29·765	29·835	29·815	29·836	29·815	29·735	29·651	29·592	29·718	...
29·642	29·658	29·705	29·768	29·843	29·890	29·871	29·871	29·831	29·760	29·697	29·638	29·765	...
29·697	29·729	29·764	29·839	29·890	29·946	29·930	29·910	29·886	29·808	29·737	29·692	29·819	...
28·382	28·402	28·434	28·481	28·497	28·564	28·524	28·512	28·489	28·434	28·382	28·362	28·455	...
28·162	28·166	28·146	28·174	28·264	28·332	28·288	28·280	28·249	28·182	28·154	28·154	28·213	...
28·160	28·178	28·264	28·310	28·280	28·300	28·272	28·284	28·340	28·256	28·182	28·134	28·247	...
27·245	27·258	27·266	27·330	27·338	27·342	27·320	27·358	27·358	27·354	27·270	27·236	27·306	...
27·390	27·390	27·414	27·457	27·485	27·536	27·500	27·536	27·485	27·454	27·410	27·406	27·455	...
28·399	28·422	28·480	28·515	28·532	28·579	28·568	28·567	28·552	28·506	28·440	28·386	28·495	...
29·733	29·741	29·749	29·804	29·906	29·950	29·902	29·965	29·863	29·833	29·784	29·715	29·829	...
29·808	29·796	29·813	29·922	29·955	30·000	29·946	29·954	29·992	29·922	29·840	29·768	29·896	...
29·713	29·753	29·776	29·843	29·886	29·926	29·922	29·926	29·910	29·823	29·753	29·713	29·829	...
29·616	29·630	29·682	29·768	29·804	29·865	29·827	29·851	29·815	29·717	29·666	29·620	29·738	...
29·863	29·878	29·906	29·957	29·980	30·018	30·034	30·014	30·006	29·961	20·922	29·855	29·949	...
29·823	29·863	29·922	29·965	30·008	30·024	30·024	30·044	29·997	29·950	29·906	29·815	29·945	...
29·717	29·800	29·859	29·918	29·910	29·946	29·934	29·938	29·997	29·886	29·764	29·710	29·865	...
29·764	29·831	29·910	29·949	29·938	30·004	29·993	30·026	30·036	29·934	29·827	29·776	29·916	...
29·784	29·854	29·945	29·997	29·977	30·024	30·032	30·067	30·083	29·965	29·851	29·776	29·946	...
29·193	29·245	29·268	29·300	29·316	29·347	29·332	29·375	29·367	29·296	29·213	29·158	29·286	...
29·768	29·815	29·851	29·886	29·882	29·930	29·922	29·946	29·954	29·914	29·831	29·753	29·871	...
29·808	29·860	29·875	29·894	29·875	29·914	29·910	29·930	29·961	29·926	29·847	29·772	29·881	...
29·382	29·340	29·481	29·564	29·560	29·516	29·465	29·516	29·445	29·470	29·394	29·414	29·462	...
29·461	29·562	29·481	29·514	29·507	29·645	29·524	29·511	29·680	29·652	29·516	29·433	29·541	...
29·343	29·343	29·383	29·466	29·454	29·378	29·377	29·410	29·520	29·376	29·322	29·378	29·396	...
29·371	29·489	29·162	29·378	29·508	29·445	29·485	29·347	29·453	29·280	29·209	29·394	29·378	...
29·426	29·634	29·272	29·493	29·737	29·630	29·642	29·652	29·843	29·296	29·375	29·477	29·540	...
29·546	29·494	29·600	29·576	29·503	29·686	29·625	29·655	29·623	29·682	29·711	29·547	29·604	...
29 506	29·531	29·491	29·555	29·563	29·674	29·630	29·654	29·678	29·586	29·622	29·523	29·585	...
29·154	29·323	29·264	29·245	29·595	29·473	29·504	29·524	29·556	29·386	29·341	29·221	29·380	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° '	° '	
North Atlantic,*	* These Atlantic Means have been calculated from the Ocean Square Data, published in the Bulletin of International Meteorology, Washington, U.S.	6	1881–86	...	12 30	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	17 ,, 30	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	22 30	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	,,	−62 30	0
Do.		6	do.	...	,,	−67 30	0
Do.		6	do.	...	,,	−72 30	0
Do.		6	do.	...	27 ,, 30	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	,,	−62 30	0
Do.		6	do.	...	,,	−67 30	0
Do.		6	do.	...	,,	−72 30	0
Do.		6	do.	...	,,	−77 30	0
Do.		6	do.	...	32 ,, 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	,,	−62 30	0
Do.		6	do.	...	,,	−67 30	0

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·005	29·991	30·000	30·001	30·004	30·017	30·004	29·974	29·981	29·991	29·987	30·000	29·996	...
30·019	30·015	30·017	30·024	30·024	30·042	30·024	29·992	30·001	30·009	30·002	30·015	30·015	...
30·041	30·039	30·034	30·044	30·059	30·071	30·056	30·006	30·004	30·019	30·007	30·025	30·034	...
30·047	30·057	30·061	30·056	30·072	30·087	30·069	30·016	30·016	30·027	30·011	30·033	30·046	...
30·066	30·054	30·069	30·062	30·074	30·097	30·081	30·027	30·026	30·026	30·011	30 032	30·052	...
30·069	30·067	30·071	30·062	30·077	30·086	30·084	30·034	30·026	30·022	30·007	30·033	30·054	...
30·066	30·054	30·059	30·054	30·069	30·086	30·076	30·016	30·017	30·014	30·009	30·033	30·046	...
30·080	30·052	30·039	30·046	30·042	30·042	30·049	30·000	30·020	30·035	30·030	39·049	30·041	...
30·077	30·080	30·064	30·067	30·070	30·095	30·072	30·020	30·035	30·047	30·045	30·056	30·060	...
30·092	30·100	30·079	30·085	30·109	30·117	30·104	30·047	30·045	30·049	30·059	30·069	30·080	...
30·090	30·109	30·097	30·095	30·129	30·134	30·127	30·064	30·054	30·054	30·068	30·079	30·092	...
30·110	30·124	30·102	30·100	30·127	30·140	30·134	30·075	30·057	30·045	30·050	30·088	30·096	...
30·114	30·125	30·110	30·094	30·120	30·134	30·127	30·077	30·055	30·042	30·044	30·079	30·094	...
30·132	30·100	30·087	30·074	30·095	30·110	30·112	30·070	30·042	30·027	30·035	30·069	30·080	...
30·125	30·095	30·074	30·059	30·057	30·084	30·085	30·044	30·019	30·000	30·000	30·051	30·058	...
30·114	30·104	30·079	30·089	30·092	30·131	30·114	30·052	30·054	30·090	30·081	30·111	30·093	...
30·119	30·139	30·107	30·107	30·134	30·157	30·134	30·081	30·084	30·094	30·092	30·113	30·117	...
30·126	30·144	30·122	30·119	30·171	30·174	30·159	30·102	30·091	30·094	30·104	30·125	30·128	...
30·136	30·174	30·137	30·119	30·187	30·194	30·184	30·124	30·097	30·082	30·100	30·131	30·139	...
30·131	30·172	30·137	30·116	30·184	30·194	30·182	30·134	30·097	30·076	30·097	30·140	30·139	...
30·138	30·162	30·117	30·104	30·169	30·177	30·184	30·134	30·087	30·071	30·087	30·131	30·130	...
30·144	30·146	30·094	30·084	30·131	30·156	30·166	30·126	30·077	30·049	30·072	30·120	30·114	...
30·124	30·141	30·100	30·069	30·102	30·129	30·152	30·102	30·057	30·024	30·054	30·111	30·098	...
30·146	30·137	30·091	30·064	30·082	30·116	30·131	30·086	30·041	30·004	30·042	30·103	30·088	...
30·147	30·136	30·101	30·062	30·064	30·096	30·122	30·074	30·027	29·991	30·036	30·100	30·080	...
30·137	30·132	30·096	30·042	30·016	30·081	30·104	30·066	30·021	29·986	30·032	30·098	30·070	...
30·145	30·163	30·133	30·122	30·145	30·183	30·168	30·123	30·118	30·135	30·112	30·167	30·143	...
30·148	30·173	30·145	30·137	30·177	30·203	30·197	30·148	30·138	30·143	30·130	30·178	30·159	...
30·145	30·180	30·146	30·142	30·202	30·210	30·222	30·173	30·148	30·135	30·150	30·175	30·170	...
30·138	30·197	30·150	30·133	30·222	30·222	30·233	30·185	30·150	30·118	30·148	30·173	30·172	...
30·137	30·190	30·140	30·117	30·218	30·218	30·245	30·185	30·137	30·112	30·145	30·182	30·169	...
30·152	30·178	30·108	30·097	30·197	30·205	30·225	30·180	30·122	30·098	30·127	30·167	30·154	...
30·152	30·173	30·088	30·070	30·165	30·185	30·205	30·170	30·110	30·083	30·110	30·157	30·139	...
30·163	30·154	30·067	30·047	30·140	30·157	30·178	30·138	30·085	30·053	30·102	30·147	30·119	...
30·168	30·155	30·073	30·050	30·095	30·132	30·158	30·112	30·068	30·027	30·082	30·145	30·106	...
30·173	30·157	30·085	30·060	30·077	30·120	30·138	30·090	30·062	30·017	30·073	30·148	30·099	...
30·173	30·158	30·092	30·055	30·057	30·098	30·117	30·073	30·042	30·027	30·090	30·143	30·094	...
30·160	30·163	30·110	30·065	30·040	30·072	30·088	30·048	30·038	30·033	30·093	30·142	30·087	...
30·178	30·161	30·078	30·049	30·101	30·134	30·121	30·078	30·121	30·130	30·111	30·183	30·121	...
30·159	30·181	30·113	30·093	30·139	30·188	30·176	30·118	30·156	30·163	30·129	30·194	30·151	...
30·141	30·179	30·133	30·136	30·168	30·219	30·224	30·171	30·168	30·188	30·143	30·206	30·173	...
30·126	30·168	30·143	30·153	30·198	30·248	30·256	30·204	30·174	30·196	30·161	30·208	30·186	...
30·123	30·168	30·139	30·135	30·214	30·243	30·268	30·221	30·178	30·184	30·171	30·231	30·188	...
30·116	30·163	30·111	30·113	30·224	30·239	30·268	30·224	30·163	30·169	30·161	30·201	30·179	...
30·126	30·159	30·091	30·089	30·213	30·233	30·248	30·224	30·163	30·146	30·151	30·196	30·170	...
30·133	30·143	30·054	30·059	30·188	30·194	30·226	30·206	30·148	30·131	30·138	30·169	30·149	...
30·139	30·144	30·014	30·026	30·149	30·173	30·201	30·186	30·124	30·097	30·128	30·153	30·128	...
30·146	30·124	30·011	30·001	30·108	30·143	30·163	30·144	30·098	30·094	30·100	30·136	30·106	...
30·141	30·134	30·000	29·986	30·061	30·104	30·136	30·101	30·088	30·051	30·081	30·114	30·083	...
30·153	30·143	30·009	30·016	30·044	30·091	30·104	30·069	30·079	30·051	30·088	30·134	30·081	...

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
North Atlantic,*	* These Atlantic Means have been calculated from the Ocean Square Data, published in the Bulletin of International Meteorology, Washington, U.S.	6	1881–86	...	32 30	−72 30	0
Do.		6	do.	...	,,	−77 30	0
Do.		6	do.	...	37 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	,,	−62 30	0
Do.		6	do.	...	,,	−67 30	0
Do.		6	do.	...	,,	−72 30	0
Do.		6	do.	...	42 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	,,	−52 30	0
Do.		6	do.	...	,,	−57 30	0
Do.		6	do.	...	,,	−62 30	0
Do.		6	do.	...	,,	−67 30	0
Do.		6	do.	...	47 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	52 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0
Do.		6	do.	...	57 30	−12 30	0
Do.		6	do.	...	,,	−17 30	0
Do.		6	do.	...	,,	−22 30	0
Do.		6	do.	...	,,	−27 30	0
Do.		6	do.	...	,,	−32 30	0
Do.		6	do.	...	,,	−37 30	0
Do.		6	do.	...	,,	−42 30	0
Do.		6	do.	...	,,	−47 30	0

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
30·163	30·156	30·041	30·034	30·039	30·066	30·073	30·056	30·071	30·066	30·104	30·154	30·086	...
30·175	30·170	30·067	30·046	30·031	30·033	30·041	30·033	30·066	30·081	30·163	30·174	30·090	...
30·122	30·144	30·037	30·027	30·062	30·132	30·115	30·089	30·105	30·114	30·135	30·183	30·105	...
30·120	30·129	30·075	30·042	30·117	30·200	30·180	30·147	30·134	30·150	30·126	30·199	30·135	...
30·112	30·120	30·107	30·057	30·132	30·247	30·242	30·202	30·174	30·195	30·142	30·222	30·163	...
30·102	30·134	30·119	30·084	30·175	30·247	30·284	30·230	30·175	30·202	30·157	30·217	30·176	...
30·070	30·100	30·095	30·052	30·179	30·235	30·255	30·209	30·164	30·190	30·150	30·195	30·157	...
30·052	30·072	30·047	30·067	30·180	30·217	30·232	30·210	30·154	30·160	30·135	30·177	30·142	...
30·052	30·070	30·010	30·024	30·169	30·179	30·187	30·192	30·135	30·134	30·115	30·147	30·117	...
30·060	30·067	29·965	30·000	30·142	30·149	30·162	30·177	30·125	30·122	30·097	30·130	30·099	...
30·064	30·040	29·927	29·965	30·112	30·115	30·130	30·152	30·110	30·085	30·092	30·115	30·074	...
30·072	30·034	29·902	29·930	30·077	30·087	30·090	30·104	30·100	30·070	30·047	30·074	30·046	..
30·060	30·052	29·905	29·939	30·044	30·050	30·054	30·074	30·087	30·084	30·047	30·069	30·039	...
30·100	30·085	29·942	29·952	30·017	30·035	30·027	30·049	30·090	30·082	30·065	30·084	30·044	...
30·120	30·119	29·977	30·000	30·030	30·015	30·000	30·039	30·085	30·107	30·102	30·124	30·060	...
30·045	30·042	29·982	29·902	30·014	30·104	30·077	30·069	30·057	30·069	30·094	30·154	30·051	...
30·017	30·020	30·014	29·954	30·057	30·165	30·142	30·119	30·072	30·107	30·067	30·155	30·074	...
30·014	30·020	30·029	30·005	30·052	30·190	30·187	30·147	30·100	30·124	30·070	30·160	30·092	...
29·994	29·980	30·019	30·017	30·080	30·187	30·197	30·145	30·107	30·134	30·064	30·137	30·088	...
29·980	29·939	29·994	29·987	30·095	30·172	30·182	30·137	30·100	30·110	30·060	30·114	30·065	...
29·935	29·915	29·945	29·942	30·089	30·137	30·132	30·127	30·082	30·085	30·035	30·102	30·044	...
29·944	29·925	29·910	29·920	30·094	30·110	30·114	30·102	30·079	30·082	30·027	30·080	30·032	...
29·965	29·925	29·865	29·904	30·080	30·080	30·077	30·097	30·090	30·075	30·002	30·045	30·017	...
29·972	29·940	29·842	29·882	30·059	30·040	30·030	30·070	30·077	30·067	29·991	30·024	30·000	...
29·984	29·957	29·835	29·884	30·035	30·002	30·004	30·045	30·090	30·059	29·992	29·998	29·990	...
30·024	29·995	29·860	29·897	30·012	29·987	29·974	30·027	30·085	30·075	30·014	30·014	29·997	...
30·054	30·040	29·902	29·930	29·989	29·964	29·949	30·009	30·082	30·100	30·035	30·050	30·008	...
29·945	29·925	29·950	29·846	29·986	30·075	30·026	30·028	29·985	29·968	29·958	30·038	29·978	...
29·901	29·880	29·946	29·870	29·986	30·096	30·031	30·021	29·970	29·991	29·941	30·030	29·972	...
29·873	29·846	29·943	29·883	29·991	30·105	30·041	30·026	29·961	29·991	29·925	30·018	29·969	...
29·845	29·806	29·905	29·886	29·998	30·100	30·051	30·013	29·960	29·986	29·896	30·006	29·955	...
29·805	29·765	29·870	29·875	29·996	30·063	30·026	29·995	29·961	29·973	29·872	29·963	29·930	...
29·786	29·773	29·841	29·841	30·008	30·051	30·025	29·996	29·971	29·958	29·875	29·950	29·922	...
29·798	29·798	29·808	29·808	30·010	30·003	29·995	29·983	29·983	29·955	29·875	29·930	29·912	...
29·805	29·813	29·778	29·825	29·993	29·961	29·960	29·975	29·998	29·973	29·878	29·913	29·906	...
29·851	29·811	29·894	29·824	29·922	30·022	29·906	29·939	29·874	29·872	29·831	29·916	29·889	...
29·800	29·742	29·882	29·817	29·929	30·001	29·892	29·924	29·849	29·861	29·802	29·898	29·866	...
29·779	29·701	29·864	29·804	29·921	30·001	29·900	29·901	29·846	29·840	29·774	29·876	29·851	...
29·722	29·669	29·829	29·800	29·922	29·987	29·911	29·889	29·832	29·819	29·757	29·848	29·833	...
29·709	29·661	29·796	29·791	29·928	29·967	29·920	29·891	29·836	29·812	29·730	29·815	29·822	...
29·704	29·656	29·774	29·792	29·930	29·940	29·906	29·889	29 824	29·814	29·736	29·795	29·811	...
29·712	29·679	29·757	29·787	29·932	29·914	29·894	29·876	29·832	29·829	29·754	29·780	27·812	...
29·746	29·696	29·756	29·781	29·936	29·876	29·861	29·862	29·837	29·849	29·774	29·780	29·813	...
29·670	29·650	29·784	29·817	29·875	29·890	29·787	29·797	29·760	29·744	29·640	29·691	29·759	...
29·642	29·610	29·767	29·794	29·890	29·880	29·787	29·794	29·730	29·700	29·620	29·666	29·740	...
29·612	29·577	29·755	29·772	29·897	29·885	29·784	29·779	29·705	29·687	29·600	29·657	29·726	...
29·592	29·553	29·739	29·774	29·892	29·865	29·809	29·782	29·695	29·692	29·603	29·647	29·720	...
29·592	29·547	29·727	29·777	29·887	29·857	29·809	29·782	29·692	29·660	29·610	29·651	29·716	...
29·569	29·554	29·709	29·769	29·880	29·835	29·815	29·774	29·682	29·662	29·637	29·654	29·711	...
29·600	29·562	29·700	29·764	29·895	29·825	29·822	29·790	29·687	29·672	29·664	29·654	29·720	...
29·610	29·587	29·700	29·762	29·885	29·810	29·812	29·785	29·700	29·684	29·694	29·646	29·723	...

ADDENDA TO TABLE VI.

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Stykkisholm, .	Iceland	15	1870–84	9 : 9	65	5	−22	46	37
Reykjavik, . .	do.	15	do.	do.	64	9	−22	0	10
Grimsey, . .	do.	15	do.	8 : 2, 9	66	34	−18	3	8
Berufiord, . .	do.	15	do.	do.	64	40	−14	15	30
Thorshavn, . .	Farö	15	do.	9 : 9	62	2	−6	43	12
Säntis, . . .	Switzerland	$4\frac{1}{3}$	1882–86	7 : 1, 9	47	15	9	20	8094
Puy de Dôme, .	France	8	1878–85	M.P.	45	47	2	57	4813
Pic-du-Midi, .	do.	4	1878–81	do.	42	57	0	8	7763
Do. . .	do.	4	1882–85	do.	42	57	0	8	9380
Mont Ventoux, .	do.	2	1885–87	do.	44	17	5	16	6234
Valdobbia, . .	Italy	7	1878–84	do.	45	47	7	51	8360
Stelvio, . .	do.	7	do.	do.	46	32	10	25	8343
P. Bernardo, .	do.	7	do.	do.	45	4	6	41	7087
Melkerei, . .	Germany	8	1879–86	8 : 2	48	25	7	18	3051
Glatzer Schneeberg,	do.	3	1884–86	7 : 2, 9	50	12	16	50	3993
Alexandropol, .	Russia	12	1854–65	7 : 2, 9	40	48	43	49	5010
Papho, . . .	Cyprus	7	1881–87	9 : 9	34	46	32	25	230
Limassol, . .	do.	7	do.	do.	34	40	33	1	26
Larnaca, . .	do.	7	do.	do.	34	55	33	37	35
Famagusta, . .	do.	7	do.	do.	35	7	33	57	75
Kyrenia, . .	do.	7	do.	do.	35	21	33	19	60
Nicosia, . .	do.	7	do.	do.	35	11	33	22	509
Beyrout, . .	Syria	7	do.	do.	35	28	33	54	112
Alexandria, . .	Egypt	7	do.	do.	31	12	29	53	62
Sant' Anna do Sobradinho, .	Brazil	$3\frac{1}{2}$	1883-86	6 : 3	−9	26	−40	47	1053
Sanchez, . .	West Indies	2	1886-87	10 : 4	19	13	−69	37	50
Fort Simpson, .	British America	$1\frac{1}{2}$	1849–51	do.	62	7	−121	33	?
Guayaquil, . .	Ecuador	$\frac{1}{6}$	1882	do.	−2	10	−79	56	25
Lick Observatory,	California	5	1881-85	M.P.	37	20	−121	39	4301

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inch.
29·370	29·492	29·617	29·786	29·838	29·757	29·726	29·724	29·653	29·572	29·646	29·498	29·662	...
29·398	29·496	29·627	29·800	29·840	29·764	29·746	29·728	29·654	29·596	29·693	29·461	29·650	...
29·476	29·577	29·696	29·864	29·896	29·798	29·755	29·764	29·720	29·616	29·723	29·585	29·716	...
29·465	29·560	29·668	29·824	29·857	29·770	29·723	29·734	29·687	29·600	29·638	29·543	29·689	...
29·582	29·668	29·724	29·855	29·880	29·845	29·765	29·793	29·759	29·651	29·688	29·624	29·736	...
22·083	22·154	22·056	22·060	22·246	22·296	22·414	22·398	22·335	22·206	22·142	22·060	22·204	...
25·123	25·093	25·057	24·939	25·113	25·182	25·250	25·226	25·190	25·100	25·090	25·090	25·120	...
22·428	22·391	22·457	22·323	22·485	22·587	22·702	22·662	22·634	22·528	22·398	22·449	22·504	...
21·205	21·193	21·032	20·981	21·210	21·300	21·402	21·406	21·290	21·197	21·162	21·127	21·210	...
23·614	23·758	23·727	23·717	23·794	23·902	24·016	23·975	23·953	23·811	23·656	23·693	23·802	...
22·122	22·103	22·050	21·993	22·170	22·242	22·335	22·327	22·268	22·166	22·110	22·040	22·160	...
22·116	22·091	22·028	21·957	22·142	22·221	22·302	22·284	22·238	22·130	22·083	22·022	22·135	...
23·067	23·036	22·985	22·890	23·079	23·146	23·237	23·221	23·163	23·083	23·040	22·998	23·079	...
26·776	26·737	26·741	26·627	26·798	26·810	26·865	26·844	26·838	26·754	26·772	26·753	26·776	...
25·776	25·874	25·820	25·764	25·890	25·878	26·000	25·980	26·008	25·843	25·867	25·737	25·870	...
24·938	24·895	24·905	24·874	24·925	24·908	24·871	24·912	24·982	25·060	25·049	24·976	24·941	...
30·065	30·042	30·000	29·916	29·944	29·884	29·791	29·796	29·934	30·018	30·066	30·082	29·961	...
30·060	30·048	29·980	29·892	29·935	29·850	29·767	29·774	29·895	30·006	30·042	30·072	29·943	...
30·067	30·039	29·985	29·906	29·933	29·852	29·756	29·767	29·895	30·016	30·053	30·093	29·947	...
30·075	30·042	29·980	29·897	29·924	29·864	29·762	29·775	29·902	30·021	30·063	30·095	29·950	...
30·072	30·048	29·980	29·901	29·932	29·864	29·766	29·770	29·888	30·007	30·043	30·076	29·946	...
30·078	30·032	29·983	29·893	29·932	29·860	29·754	29·770	29·904	30·008	30·040	30·078	29·944	...
30·080	30·069	30·023	29·950	29·970	29·910	29·810	29·796	29·947	30·025	30·069	30·103	29·980	−·080
30·080	30·072	30·022	29·950	29·979	29·930	29·855	29·855	29·954	30·029	30·069	30·084	29·990	...
28·856	28·852	28·852	28·863	28·891	28·950	28·974	28·962	28·950	28·863	28·836	28·832	28·891	+·170
30·075	30·115	30·067	30·013	30·023	30·040	30·075	29·998	29·982	29·970	29·997	30·066	30·035	...
27·962	27·835	27·942	28·025	27·906	27·733	...	...	...	27·706	27·613	28·015	..	...
...	29·960	29·945	...	...	...	...	...	...	...	...	...	...	...
25·729	25·717	25·686	25·666	25·678	25·733	27·768	25·745	25·721	25·705	25·752	25·697	25·717	...

TABLE VII.

Showing the Average Number of Days each Month the Wind has prevailed from North, North-East, East, etc., at Different Places over the Globe.

Note.—As regards "Hours of Observations," the A.M. Observations are placed before the colon [:], the P.M. after it. A Minus sign before Latitudes indicates Latitude South, and before Longitudes, Longitude West.

MULLAGHMORE.
Lat. 54° 28′. Long. −8° 28′.
Height 40 ft.
7 Years, 1879, 1881–86. Hour 8:

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	5	6	3	9	4	2	0
Feb.	1	1	4	4	5	9	3	1	0
March	2	2	5	5	3	8	4	2	0
April	2	3	9	4	3	4	2	2	1
May	2	3	6	2	2	7	5	3	1
June	2	2	4	2	2	6	6	5	1
July	2	1	2	3	4	9	6	3	1
Aug.	2	1	4	2	4	7	5	5	1
Sept.	3	1	5	3	5	6	3	3	1
Oct.	3	2	4	5	4	5	4	4	0
Nov.	3	2	2	3	4	8	4	4	0
Dec.	3	2	3	2	3	7	6	4	1
Year	26	21	53	41	42	85	52	38	7

MARKREE.
Lat. 54° 11′. Long. −8° 27′.
Height 131 ft.
12 Years, 1875–86. Hours 9: 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	7	6	5	2	2	6
Feb.	2	1	1	5	5	4	2	2	6
March	2	2	2	5	4	4	2	4	6
April	2	3	3	7	3	3	1	2	6
May	3	1	2	4	3	4	4	4	6
June	4	1	2	4	4	3	1	4	7
July	2	1	1	3	4	4	2	5	9
Aug.	2	1	2	4	5	3	2	3	9
Sept.	2	1	2	4	5	3	2	3	8
Oct.	3	1	2	6	4	3	2	2	8
Nov.	2	1	1	4	4	5	2	3	8
Dec.	2	1	1	4	4	5	2	3	9
Year	27	15	20	57	51	46	24	37	88

ARMAGH.
Lat. 54° 21′. Long. −6° 39′.
Height 207 ft.
14 Years, 1870–83. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	4	11	8	2	1	...
Feb.	2	2	2	3	9	7	2	1	...
March	3	3	3	2	6	8	4	2	...
April	3	5	4	3	6	5	2	2	...
May	4	4	3	2	5	6	4	3	...
June	3	4	2	2	6	7	3	3	...
July	2	3	1	1	6	10	5	3	...
Aug.	2	4	3	2	5	8	5	2	...
Sept.	1	3	2	2	7	10	2	3	...
Oct.	2	3	3	3	8	8	3	1	...
Nov.	2	2	2	3	9	8	2	2	...
Dec.	2	2	3	1	9	11	2	1	...
Year	27	37	30	28	87	96	36	24	...

DONAGHADEE.
Lat. 54° 38′. Long. −5° 34′.
Height 30 ft.
9 Years, 1876–79, 1881–86. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	4	7	7	6	3	...
Feb.	1	1	3	3	4	6	7	3	...
March	3	1	4	3	4	6	7	3	...
April	2	5	6	5	4	3	3	2	...
May	4	4	4	3	4	4	5	3	...
June	5	4	3	2	5	4	5	2	...
July	4	3	2	2	3	5	8	4	...
Aug.	3	4	3	2	4	4	7	4	...
Sept.	2	3	3	2	4	5	8	3	...
Oct.	2	2	3	3	6	5	7	3	...
Nov.	2	2	2	2	4	7	8	3	...
Dec.	1	3	2	1	3	7	11	3	...
Year	30	33	37	32	52	63	82	36	...

DUBLIN.
Lat. 53° 22′. Long. −6° 21′.
Height 158 ft.
15 Years, 1870–84. Hours 9: 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	3	3	4	8	8	1	3
Feb.	1	1	2	3	3	6	7	2	3
March	2	1	4	3	2	6	8	3	2
April	2	2	6	4	2	3	6	3	2
May	3	3	5	2	2	5	7	2	2
June	2	2	4	2	3	5	7	3	2
July	1	2	2	1	4	8	9	2	2
Aug.	2	2	3	2	3	5	9	2	3
Sept.	2	1	3	2	2	6	8	3	3
Oct.	2	2	3	3	3	4	10	1	3
Nov.	2	1	2	2	3	5	9	2	4
Dec.	1	1	2	2	3	6	10	2	4
Year	21	18	39	29	34	67	98	26	33

PARSONSTOWN.
Lat. 53° 6′. Long. −7° 55′.
Height 182 ft.
13 Years, 1873, 1875–86. Hours 9: 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	6	6	5	4	1	5
Feb.	1	1	1	5	5	5	4	2	4
March	2	2	2	4	4	6	4	3	4
April	3	3	3	5	4	3	3	2	4
May	3	2	2	4	4	4	4	4	4
June	2	1	1	3	4	5	5	4	5
July	1	1	1	3	4	6	5	5	5
Aug.	1	2	1	4	4	6	5	3	5
Sept.	2	1	2	4	4	4	4	3	6
Oct.	2	1	2	4	4	5	3	3	7
Nov.	1	1	2	4	4	5	4	3	6
Dec.	1	1	1	4	5	6	5	2	6
Year	20	17	20	50	52	60	50	35	61

CORK.
Lat. 51° 53′. Long. −8° 28′.
Height 25 ft.
11 Years, 1857–67. Hour 9:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	1	5	3	8	2	8	...
Feb.	1	3	2	5	1	7	3	6	...
March	1	4	2	5	1	5	4	9	...
April	1	4	3	5	2	6	3	6	...
May	2	2	4	7	2	6	3	5	...
June	1	2	1	5	3	6	4	8	...
July	1	1	1	3	2	7	6	10	...
Aug.	1	1	1	4	4	7	5	8	...
Sept.	1	1	2	4	3	8	4	7	...
Oct.	1	3	2	6	2	7	2	8	...
Nov.	1	3	3	5	3	6	1	8	...
Dec.	1	2	1	5	3	9	3	7	...
Year	14	28	23	59	29	82	40	90	...

ROCHES POINT.
Lat. 51° 47′. Long. −8° 19′.
Height 32 ft.
10 Years, 1876–79, 1881–86. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	1	4	4	6	6	3	...
Feb.	3	2	1	3	3	6	7	3	...
March	5	3	2	3	3	4	6	5	...
April	5	3	4	5	4	4	2	3	...
May	7	2	4	4	3	4	4	3	...
June	6	1	2	3	4	5	4	5	...
July	6	1	1	2	4	6	5	6	...
Aug.	5	2	2	2	3	5	7	5	...
Sept.	6	2	2	3	2	5	5	5	...
Oct.	5	3	1	4	4	4	6	4	...
Nov.	4	2	1	2	4	5	8	4	...
Dec.	7	2	1	1	3	5	7	5	...
Year	63	26	22	36	41	59	67	51	...

VALENCIA.
Lat. 51° 55′. Long. −10° 18′.
Height 23 ft.
15 Years, 1870–84. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	3	5	6	5	5	2	0
Feb.	2	3	3	5	4	4	5	2	0
March	3	4	4	3	4	4	5	4	0
April	4	4	4	5	3	3	3	3	1
May	5	4	3	3	3	5	4	3	1
June	3	2	2	3	4	5	5	5	1
July	3	2	1	4	5	5	6	5	0
Aug.	3	2	2	4	4	5	6	4	1
Sept.	3	3	2	4	3	4	5	4	2
Oct.	3	4	3	4	4	4	5	3	1
Nov.	3	5	3	4	3	3	5	3	1
Dec.	3	3	3	4	5	4	4	4	1
Year	37	39	33	48	48	51	58	42	9

NORTH UNST. Lat. 60° 51′. Long. —0° 53′. Height 230 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	2	8	6	6	3	...
Feb.	4	2	2	2	8	4	4	2	...
March	6	3	2	2	7	4	5	2	...
April	6	4	3	3	6	3	3	2	...
May	8	3	2	2	4	4	5	3	...
June	5	3	3	4	5	4	4	2	...
July	5	3	4	3	5	4	5	2	...
Aug.	5	3	3	3	5	4	5	3	...
Sept.	6	2	2	2	6	5	4	3	...
Oct.	4	2	2	3	9	4	5	2	...
Nov.	6	4	2	2	6	4	3	3	...
Dec.	5	2	2	3	6	4	6	3	...
Year	63	32	29	31	75	50	55	30	...

SANDWICK. Lat. 59° 2′. Long. —3° 18′. Height 94 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	5	7	6	5	3	2
Feb.	2	1	1	6	4	4	5	3	2
March	2	2	1	7	4	4	5	5	1
April	3	3	3	7	3	3	3	4	1
May	3	3	2	6	2	4	5	5	1
June	3	2	2	7	3	3	4	5	1
July	2	1	2	7	3	4	5	5	2
Aug.	2	2	3	6	1	4	5	5	3
Sept.	3	2	2	5	3	4	5	4	2
Oct.	3	1	1	6	5	4	5	4	2
Nov.	4	2	1	4	4	4	4	4	3
Dec.	3	2	2	3	5	5	5	4	2
Year	31	22	21	69	44	49	56	51	22

BUTT OF LEWIS. Lat. 58° 31′. Long. —6° 16′. Height 170 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	4	8	8	3	3	...
Feb.	2	2	4	4	6	5	3	2	...
March	4	2	4	4	5	5	4	3	...
April	3	3	7	4	4	4	2	3	...
May	4	5	5	2	3	6	4	2	...
June	3	4	6	3	4	4	3	3	...
July	3	3	4	4	4	5	5	3	...
Aug.	3	3	5	3	4	5	5	3	...
Sept.	4	4	3	3	4	6	3	3	...
Oct.	3	2	3	3	7	5	5	3	...
Nov.	4	3	3	3	6	5	3	3	...
Dec.	3	2	3	3	7	6	4	3	...
Year	38	34	49	40	62	64	44	34	...

MONACH. Lat. 57° 32′. Long. —7° 38′. Height 20 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	2	10	5	6	3	0
Feb.	2	2	3	2	7	5	5	2	0
March	4	2	3	2	7	4	5	3	1
April	4	3	5	3	6	3	3	2	1
May	4	4	3	2	5	4	5	3	1
June	4	3	3	2	6	5	3	3	1
July	5	2	2	1	6	6	5	3	1
Aug.	4	2	4	2	5	5	4	4	1
Sept.	4	3	3	2	5	5	5	2	1
Oct.	3	2	3	2	6	5	7	3	0
Nov.	5	3	3	2	6	4	5	2	0
Dec.	3	2	3	2	7	4	6	4	0
Year	44	29	37	24	76	55	59	34	7

SKERRYVORE. Lat. 56° 19′. Long. —7° 7′. Height 150 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	5	8	6	6	2	0
Feb.	3	1	2	6	6	5	4	2	0
March	4	2	2	5	5	5	4	4	0
April	4	3	3	7	5	4	2	2	0
May	5	3	2	4	4	5	4	4	0
June	4	2	2	4	5	5	4	4	0
July	4	2	1	3	5	6	5	5	0
Aug.	4	2	2	4	5	5	5	3	1
Sept.	4	2	1	4	5	6	5	3	0
Oct.	3	2	1	5	6	5	5	3	0
Nov.	4	3	2	4	5	5	4	3	0
Dec.	3	2	2	4	6	5	5	4	0
Year	44	25	21	55	65	62	53	39	1

TARBETNESS. Lat. 57° 52′. Long. —3° 47′. Height 175 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	4	4	11	6	3	0
Feb.	2	1	2	5	4	6	5	3	0
March	4	2	3	4	3	6	5	4	0
April	3	3	7	4	3	3	3	3	1
May	3	5	6	2	2	5	4	4	0
June	2	3	7	4	2	4	4	3	1
July	2	3	5	3	3	5	4	5	1
Aug.	2	3	5	4	2	5	4	5	1
Sept.	2	3	3	3	3	6	4	5	1
Oct.	3	1	3	3	4	7	6	4	0
Nov.	4	2	1	4	3	7	5	4	0
Dec.	2	1	1	3	3	9	7	5	0
Year	30	28	44	43	36	74	57	48	5

BUCHANNESS. Lat. 57° 28′. Long. —1° 46′. Height 130 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	2	6	9	5	5	0
Feb.	3	2	2	3	5	5	4	4	0
March	4	2	2	3	5	6	4	5	0
April	3	4	3	5	4	5	2	4	0
May	5	4	2	2	5	5	3	4	1
June	5	3	1	3	7	5	2	3	1
July	5	2	2	3	6	5	3	4	1
Aug.	5	3	2	3	6	4	3	4	1
Sept.	5	2	2	2	6	4	4	4	1
Oct.	3	1	2	3	5	7	5	5	0
Nov.	4	3	2	2	4	6	4	5	0
Dec.	3	2	2	2	3	8	5	6	0
Year	47	29	23	33	62	69	44	53	5

BEN NEVIS. Lat. 56° 49′. Long. —5° 7′. Height 4406 ft. 4 Years, 1884–87. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	3	4	4	4	5	3	0
Feb.	3	1	3	4	5	6	3	3	0
March	5	5	3	4	5	3	3	3	0
April	5	3	3	5	4	2	3	3	2
May	4	5	3	5	3	3	4	2	2
June	5	3	2	2	3	4	5	3	3
July	5	1	1	4	5	4	6	3	2
Aug.	5	2	2	4	6	3	4	3	2
Sept.	7	2	2	3	5	3	4	2	2
Oct.	10	3	3	3	3	3	3	2	1
Nov.	7	3	3	3	4	4	3	3	0
Dec.	9	4	2	2	2	3	5	3	1
Year	69	36	30	43	49	42	48	33	15

ISLE OF MAY. Lat. 56° 11′. Long. —2° 33′. Height 240 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	3	4	3	15	2	1
Feb.	1	2	2	3	4	3	11	1	1
March	2	4	3	4	3	2	10	2	1
April	1	3	6	5	2	2	8	1	2
May	1	3	5	4	2	3	10	1	2
June	1	3	4	5	3	2	8	1	3
July	1	2	4	4	3	2	12	1	2
Aug.	1	2	5	4	2	2	11	2	2
Sept.	1	3	3	3	2	3	12	1	2
Oct.	2	2	2	3	3	3	12	3	1
Nov.	2	4	3	1	3	3	10	3	1
Dec.	1	3	2	2	2	3	15	2	1
Year	15	32	40	41	33	31	134	20	19

ST. ABB'S HEAD. Lat. 55° 55′. Long. −2° 11′. Height 224 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	4	4	10	6	4	0
Feb.	2	2	2	5	3	6	5	3	0
March	3	3	3	4	2	6	6	3	1
April	3	3	4	6	2	4	4	3	1
May	3	4	2	5	2	6	5	3	1
June	3	3	2	6	2	4	5	3	2
July	2	2	2	4	3	5	7	4	2
Aug.	2	3	2	5	3	5	6	4	1
Sept.	3	3	2	4	3	6	5	3	1
Oct.	3	2	2	4	4	7	6	3	0
Nov.	4	3	2	2	4	6	5	4	0
Dec.	3	3	2	3	3	8	6	4	0
Year	32	31	26	52	35	73	66	41	9

MULL OF GALLOWAY. Lat. 54° 38′. Long. −4° 15′. Height 325 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	3	4	8	7	4	2	...
Feb.	3	1	4	3	6	5	4	2	...
March	4	1	5	3	5	5	4	4	...
April	3	2	7	4	5	3	3	3	...
May	3	2	5	2	6	4	4	5	...
June	3	1	3	3	7	5	4	4	...
July	2	1	2	1	8	6	6	5	...
Aug.	3	2	3	3	6	5	5	4	...
Sept.	3	2	3	2	6	5	5	4	...
Oct.	3	2	3	4	6	4	5	4	...
Nov.	4	2	3	3	5	5	5	3	...
Dec.	4	2	3	3	5	7	4	3	...
Year	37	19	44	35	73	61	53	43	...

POINT OF AYRE. Lat. 54° 25. Long. −4° 22′. Height 106 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	5	6	4	8	3	0
Feb.	2	2	3	5	4	3	6	3	0
March	3	2	4	4	4	2	7	4	1
April	2	3	5	6	3	2	5	3	1
May	2	4	3	2	3	3	7	5	2
June	2	2	3	3	4	3	7	5	1
July	1	1	2	4	3	3	9	7	1
Aug.	2	2	3	4	3	3	8	5	1
Sept.	3	3	2	3	3	3	7	5	1
Oct.	3	2	3	4	4	3	7	4	1
Nov.	4	3	3	4	4	3	6	3	0
Dec.	3	3	2	4	4	3	8	4	0
Year	29	28	35	48	45	35	85	51	9

SILLOTH. Lat. 54° 52′. Long. −3° 22′. Height 28 ft. 15 Years, 1870–84. Hours, 9 : 9

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	5	3	1	9	5	3	2
Feb.	2	2	5	2	2	7	4	2	2
March	3	3	6	2	1	6	5	4	1
April	2	3	9	3	1	4	5	2	1
May	1	2	7	3	1	6	7	2	2
June	1	2	5	3	1	7	7	2	2
July	1	1	4	1	1	10	10	1	2
Aug.	1	1	6	2	1	7	8	3	2
Sept.	2	1	5	2	1	6	7	3	3
Oct.	2	1	6	3	1	6	6	3	3
Nov.	3	3	4	2	1	6	5	3	3
Dec.	3	4	4	2	1	8	5	2	2
Year	23	24	66	28	13	82	74	30	25

STONYHURST. Lat. 53° 51′. Long. −2° 28′. Height 361 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	3	1	5	8	7	1	...
Feb.	1	4	4	1	4	6	6	2	...
March	1	6	4	1	3	6	7	3	...
April	1	8	5	1	2	5	7	1	...
May	1	7	3	1	2	5	10	2	...
June	1	5	4	1	2	6	9	2	...
July	1	3	2	0	2	9	12	2	...
Aug.	1	5	2	2	2	7	10	2	...
Sept.	2	5	2	1	3	6	8	3	...
Oct.	2	5	3	1	3	7	7	3	...
Nov.	2	7	2	1	3	6	6	3	...
Dec.	2	7	1	1	3	7	7	3	...
Year	16	67	35	12	34	78	96	27	...

LLANDUDNO. Lat. 53° 21′. Long. −3° 50′. Height 100 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	3	2	4	6	12	1	1
Feb.	2	1	3	2	3	5	11	1	0
March	2	3	5	2	2	3	12	2	0
April	2	3	7	2	3	2	8	2	1
May	3	3	7	1	2	3	10	2	0
June	4	2	4	1	2	3	11	3	0
July	3	2	2	0	2	4	15	3	0
Aug.	2	1	3	2	2	3	16	2	0
Sept.	3	2	4	1	2	3	12	3	0
Oct.	2	2	4	3	3	5	10	2	0
Nov.	3	2	3	1	3	4	12	2	0
Dec.	2	2	3	2	2	4	14	2	0
Year	29	24	48	19	30	45	143	25	2

GREENWICH. Lat. 51° 29′. Long. 0° 0′. Height 159 ft. 20 Years, 1841–60. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	1	2	4	10	3	2	3
Feb.	3	4	2	1	3	8	3	2	2
March	4	4	3	2	2	8	3	3	2
April	4	6	3	2	3	6	3	2	1
May	4	7	3	2	3	7	2	1	2
June	3	4	2	2	2	10	4	2	1
July	3	4	1	1	3	10	4	2	3
Aug.	3	3	1	1	3	11	4	2	3
Sept.	4	5	2	2	2	7	2	2	4
Oct.	3	3	1	2	3	9	4	2	4
Nov.	4	4	2	2	3	8	2	2	3
Dec.	3	2	2	2	3	9	4	2	4
Year	41	49	23	21	34	103	38	24	32

KEW. Lat. 51° 28′. Long. −0° 19′. Height 34 ft. 15 Years, 1870–84. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	3	2	6	8	4	2	...
Feb.	3	3	3	2	5	7	3	2	...
March	4	5	3	1	3	7	5	3	...
April	4	5	4	2	4	5	4	2	...
May	5	6	3	1	3	7	4	2	...
June	4	4	2	1	5	7	5	2	...
July	3	2	1	1	5	11	6	2	...
Aug.	3	3	3	1	4	9	6	2	...
Sept.	3	4	3	1	3	8	6	2	...
Oct.	3	4	3	1	5	8	4	3	...
Nov.	4	3	2	1	4	8	4	4	...
Dec.	4	3	2	1	4	9	5	3	...
Year	43	45	32	15	51	94	56	29	...

FALMOUTH. Lat. 50° 9′. Long. −5° 4′. Height 211 ft. 15 Years, 1870–84. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	2	3	6	6	5	3	...
Feb.	3	2	2	3	5	5	6	2	...
March	5	2	4	2	4	4	5	5	...
April	4	4	5	2	3	3	5	4	...
May	4	4	5	2	4	4	3	5	...
June	3	1	2	2	5	5	5	7	...
July	2	1	2	2	4	6	8	6	...
Aug.	3	1	4	2	3	5	7	6	...
Sept.	3	1	3	2	4	4	7	6	...
Oct.	4	2	2	3	5	4	6	5	...
Nov.	4	2	2	2	4	4	7	5	...
Dec.	4	2	1	2	4	5	7	6	...
Year	43	24	34	27	51	55	71	60	...

JERSEY. Lat. 49° 12′. Long. −2° 7′. Height 50 ft. 15 Years, 1870–84. Hours 9: 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	2	4	5	6	4	2	3
Feb.	1	4	1	4	4	5	4	2	3
March	1	6	3	4	2	4	5	3	3
April	1	6	3	3	3	5	5	3	1
May	2	7	2	2	2	6	5	3	2
June	2	4	1	1	3	7	6	3	3
July	1	3	1	1	2	8	10	2	3
Aug.	1	4	1	1	2	8	9	2	3
Sept.	1	4	2	2	3	7	7	2	2
Oct.	1	4	2	2	5	5	6	2	4
Nov.	2	4	1	4	4	5	5	2	3
Dec.	1	3	1	4	4	5	5	3	5
Year	15	53	20	32	39	71	71	29	35

HAPARANDA. Lat 65° 50′. Long. 24° 9′. Height 30 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N W	CA.
Jan.	6	2	1	3	6	6	1	3	3
Feb.	6	2	1	3	6	4	1	2	3
March	7	2	1	2	6	6	1	3	3
April	6	3	1	2	7	5	1	2	3
May	7	4	2	2	7	5	1	1	2
June	6	4	1	1	7	6	1	2	2
July	4	4	1	2	9	5	1	1	4
Aug.	5	4	1	2	7	5	1	2	4
Sept.	5	3	2	2	7	5	1	2	3
Oct.	5	3	2	3	5	6	2	2	3
Nov.	7	4	2	3	4	4	1	2	3
Dec.	6	4	2	4	4	4	1	2	4
Year	70	39	17	29	75	61	13	24	37

UMEÅ. Lat. 63° 49′. Long. 20° 18′. Height 41 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	1	1	2	6	1	4	8
Feb.	4	4	1	0	2	6	1	4	6
March	4	4	1	1	2	7	1	4	7
April	4	5	1	1	3	6	1	4	5
May	4	5	3	1	4	5	1	4	4
June	2	4	3	2	5	6	1	4	3
July	2	4	2	2	5	8	1	3	4
Aug.	3	4	2	1	3	6	1	4	7
Sept.	3	3	2	1	2	6	1	5	7
Oct.	4	2	1	1	3	7	1	4	8
Nov.	5	3	1	1	3	4	1	4	8
Dec.	5	4	1	1	2	4	1	4	9
Year	44	46	19	13	36	71	12	48	76

HERNÖSAND. Lat. 62° 38′. Long. 17° 58′. Height 45 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	1	1	5	4	2	2	8
Feb.	4	4	1	1	3	3	2	2	8
March	3	4	2	1	5	3	3	3	7
April	4	4	2	1	3	3	2	3	8
May	3	6	3	1	5	2	2	3	6
June	2	5	4	2	6	2	2	3	4
July	3	4	2	2	7	2	2	3	6
Aug.	3	4	2	1	6	2	2	3	8
Sept.	2	3	2	2	6	2	2	3	8
Oct.	4	2	2	1	6	3	3	3	7
Nov.	5	3	1	2	4	4	2	2	7
Dec.	5	4	1	2	3	3	2	2	9
Year	43	46	23	17	59	33	26	32	86

CARLSTAD. Lat. 59° 23′. Long. 13° 30′. Height 179 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	1	2	5	4	1	4	9
Feb.	1	6	1	2	3	3	1	3	8
March	1	5	1	3	4	3	1	4	9
April	1	5	1	4	4	2	1	3	9
May	1	5	1	4	6	5	0	2	7
June	1	4	1	5	7	5	0	1	6
July	1	2	1	5	8	5	1	2	6
Aug.	1	3	1	5	6	5	1	2	7
Sept.	1	3	1	5	5	4	1	2	8
Oct.	1	5	1	4	6	3	0	4	7
Nov.	1	6	1	3	4	3	1	4	7
Dec.	2	6	1	3	3	3	0	4	9
Year	13	54	12	45	61	45	8	35	92

GÖTEBORG. Lat. 57° 42′. Long. 11° 59′. Height 22 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	3	3	7	5	4	1	4
Feb.	1	4	5	3	4	3	4	1	3
March	2	4	4	2	5	4	5	1	4
April	2	3	5	2	3	4	5	2	4
May	2	3	4	1	4	4	8	3	2
June	1	3	3	2	3	5	9	2	2
July	1	1	2	2	4	5	11	2	3
Aug.	1	2	3	2	4	4	8	1	6
Sept.	1	2	4	2	4	4	7	1	5
Oct.	1	3	6	3	6	3	4	1	4
Nov.	2	3	5	3	5	4	3	0	5
Dec.	2	4	6	3	5	4	4	0	3
Year	17	35	50	28	54	49	72	15	45

WESTERVIK. Lat. 57° 46′. Long. 16° 32′. Height 44 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	1	1	3	4	4	14
Feb.	1	2	1	2	2	2	3	3	12
March	2	3	1	1	2	3	3	4	12
April	2	3	3	2	1	2	2	3	12
May	2	3	3	2	2	2	3	3	11
June	2	3	3	3	2	3	4	3	7
July	1	2	2	4	3	4	4	4	7
Aug.	1	2	3	3	2	3	4	4	9
Sept.	2	2	2	2	2	4	3	4	9
Oct.	2	2	2	2	2	4	3	3	11
Nov.	2	3	1	2	2	3	4	3	10
Dec.	2	2	1	2	2	3	3	3	13
Year	21	28	23	26	23	36	40	41	127

WISBY. Lat. 57° 39′. Long. 18° 19′. Height 52 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	3	3	4	6	5	3	2
Feb.	3	2	4	3	3	5	4	3	1
March	4	3	3	2	3	5	6	3	2
April	3	4	4	3	3	4	6	2	1
May	4	5	2	2	3	4	6	3	2
June	4	4	2	2	3	4	7	2	2
July	4	2	1	2	4	4	8	4	2
Aug.	3	3	3	2	3	4	7	4	2
Sept.	3	2	3	3	3	4	6	4	2
Oct.	2	2	4	3	5	6	4	3	2
Nov.	3	3	4	3	4	5	4	3	1
Dec.	3	3	4	4	4	4	5	3	1
Year	39	35	37	32	42	55	68	37	20

HALMSTAD. Lat. 56° 40′. Long. 12° 52′. Height 34 ft. 13 Years, 1870–82. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	4	3	4	4	6	3	3
Feb.	1	2	4	4	4	2	5	3	3
March	2	1	4	2	4	3	6	4	5
April	2	2	5	4	3	2	5	4	3
May	3	1	3	3	3	3	7	6	2
June	2	1	2	2	4	2	7	6	4
July	2	1	1	2	4	2	8	7	4
Aug.	2	1	3	3	4	2	7	5	4
Sept.	2	1	3	3	4	2	6	5	4
Oct.	2	1	5	4	4	3	4	4	4
Nov.	3	2	5	2	4	3	5	3	3
Dec.	3	2	7	3	4	2	5	2	3
Year	26	17	46	35	46	30	71	52	42

THORSHAVN. Lat. 62° 2′. Long. −6° 43′. Height 12 ft. 15 Years, 1870–84. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	1	4	4	8	3	3	2
Feb.	3	3	2	5	3	5	3	2	2
March	5	4	2	5	2	5	4	3	1
April	3	5	4	4	2	4	3	2	3
May	5	5	3	3	2	4	4	2	3
June	2	4	4	4	1	5	4	1	5
July	3	6	3	3	1	4	4	1	6
Aug.	4	5	2	2	3	4	4	1	6
Sept.	5	4	1	3	2	6	4	2	3
Oct.	4	3	2	4	3	5	4	3	3
Nov.	5	4	2	4	3	3	2	4	3
Dec.	5	3	2	4	2	6	4	3	2
Year	47	49	28	45	28	59	43	27	39

SKAGEN. Lat. 57° 44′. Long. 10° 38′. Height 10 ft. 13 Years, 1873–85. Hours, 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	4	2	3	6	6	3	2
Feb.	1	4	5	3	3	5	4	2	1
March	3	4	4	3	3	4	5	3	2
April	2	5	6	3	2	2	4	3	3
May	3	4	3	3	3	3	7	4	1
June	2	2	2	3	3	3	9	4	2
July	2	2	2	3	3	4	10	4	1
Aug.	2	2	2	3	3	4	8	4	3
Sept.	1	2	3	3	4	5	7	3	2
Oct.	2	3	4	3	4	6	5	3	1
Nov.	2	4	3	3	3	6	5	2	2
Dec.	2	4	4	3	3	5	6	3	1
Year	23	40	42	35	37	53	76	38	21

VESTERVIG. Lat. 56° 47′. Long. 8° 20′. Height 82 ft. 12 Years, 1874–85. Hours 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	4	4	4	6	4	2	3
Feb.	1	3	5	4	4	4	3	2	2
March	1	4	4	2	3	5	5	4	3
April	1	5	6	3	2	3	3	5	2
May	2	3	3	2	2	6	5	5	3
June	1	2	2	2	2	6	6	6	3
July	1	1	2	2	2	6	8	6	3
Aug.	1	2	3	3	2	5	6	5	4
Sept.	1	2	4	3	3	4	5	5	3
Oct.	1	4	4	4	3	4	4	4	3
Nov.	1	4	3	5	4	4	3	2	4
Dec.	1	3	4	4	4	5	4	3	3
Year	13	36	44	38	35	58	56	49	36

FANÖ. Lat. 55° 27′. Long. 8° 24′. Height 18 ft. 13 Years, 1873–85. Hours 8 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	3	3	4	6	8	2	1
Feb.	2	2	4	3	5	4	6	2	0
March	2	2	4	3	2	5	8	4	1
April	2	4	7	3	2	3	6	3	0
May	3	2	3	3	2	4	8	6	0
June	1	1	3	2	2	5	8	7	1
July	1	0	2	2	2	6	10	7	1
Aug.	1	1	2	3	3	6	9	5	1
Sept.	1	2	3	3	3	5	8	4	1
Oct.	2	3	4	3	4	5	6	3	1
Nov.	3	3	3	3	5	5	5	2	1
Dec.	2	2	4	3	4	5	8	3	0
Year	22	24	42	34	38	59	90	48	8

HERNING. Lat. 56° 8′. Long. 8° 58′. Height 195 ft. 12 Years, 1874–85. Hours 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	4	3	4	6	3	3	5
Feb.	1	3	4	4	3	5	3	2	3
March	2	2	4	2	2	6	5	4	4
April	1	4	6	3	2	3	3	3	5
May	1	3	3	3	2	5	5	4	5
June	1	1	2	2	2	6	6	5	5
July	1	1	1	2	2	7	7	5	5
Aug.	1	1	3	3	2	5	5	4	7
Sept.	1	2	2	3	4	5	4	3	6
Oct.	1	4	3	3	4	5	3	3	5
Nov.	2	3	3	4	3	5	3	2	5
Dec.	1	3	3	3	4	6	3	2	6
Year	14	29	38	35	34	64	50	40	61

SAMSÖ. Lat. 55° 50′. Long. 10° 36′. Height 66 ft. 13 Years, 1873–85. Hours 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	2	2	4	8	5	2	4
Feb.	2	3	3	3	3	6	4	2	2
March	2	3	3	3	2	7	5	2	4
April	2	5	5	3	2	4	3	2	4
May	2	3	3	3	3	6	4	3	4
June	1	2	2	2	5	3	6	3	6
July	1	1	2	2	3	7	8	2	5
Aug.	1	2	2	2	4	7	6	2	5
Sept.	1	1	2	3	4	7	5	2	5
Oct.	1	3	3	2	4	6	4	2	6
Nov.	2	2	2	3	4	7	4	2	4
Dec.	2	2	3	3	3	8	4	2	4
Year	19	29	32	31	41	76	58	26	53

COPENHAGEN. Lat. 55° 41′. Long. 12° 36′. Height 43 ft. 15 Years, 1870–84. Hours 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	2	4	4	7	4	4	1
Feb.	2	2	3	5	4	5	3	3	1
March	2	3	3	4	4	5	4	5	1
April	2	3	4	6	3	3	3	5	1
May	4	2	2	4	4	4	3	6	2
June	3	2	2	5	3	3	4	7	1
July	1	1	1	4	5	5	5	7	2
Aug.	2	2	2	4	4	6	4	6	1
Sept.	1	1	2	4	4	6	4	5	3
Oct.	1	2	4	5	4	6	3	5	1
Nov.	2	3	3	3	4	7	4	3	1
Dec.	2	3	3	4	4	7	3	4	1
Year	24	27	31	52	47	64	44	60	16

COPENHAGEN. Lat. 55° 41′. Long. 12° 35′. Height 12 ft. 78 Years, 1808–85. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	3	4	5	6	4	4	...
Feb.	2	2	3	4	4	6	4	3	...
March	2	3	4	4	4	5	5	4	...
April	3	3	4	5	4	3	4	4	...
May	3	2	4	5	4	4	4	5	...
June	2	2	2	4	4	5	5	6	...
July	2	1	2	4	5	5	6	6	...
Aug.	2	2	2	4	4	6	6	5	...
Sept.	2	2	2	4	4	6	5	5	...
Oct.	2	2	3	5	4	7	4	4	...
Nov.	2	3	3	4	5	7	4	2	...
Dec.	2	3	3	4	4	8	4	3	...
Year	26	28	35	51	51	68	55	51	...

BOGÖ. Lat. 54° 55′. Long. 12° 4′. Height 88 ft. 13 Years, 1873–85. Hours 8 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	3	4	3	7	6	3	1
Feb.	1	3	4	4	3	5	5	2	1
March	1	4	5	3	2	5	6	4	1
April	1	7	7	3	1	3	5	2	1
May	1	3	5	3	1	4	8	4	2
June	1	3	4	2	1	4	8	5	2
July	1	2	3	3	2	5	9	4	2
Aug.	1	2	4	3	2	6	8	3	2
Sept.	0	2	4	3	2	7	6	3	3
Oct.	1	3	4	4	3	7	4	3	2
Nov.	2	3	2	4	3	7	4	3	2
Dec.	2	3	4	3	2	7	6	3	1
Year	13	38	49	39	25	67	75	39	20

Month.	HAMMERSHUS. Lat. 55° 17′. Long. 14° 40′. Height 50 ft. 13 Years, 1873–85. Hours 8 : 2, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	3	2	3	10	4	2	2
Feb.	1	3	3	3	3	8	3	2	2
March	2	4	3	3	2	10	3	2	2
April	1	7	5	3	1	7	2	1	3
May	1	4	4	3	1	12	3	1	3
June	1	3	3	3	1	12	3	1	3
July	1	2	2	3	1	13	4	2	3
Aug.	1	3	3	3	2	10	4	3	2
Sept.	1	2	3	3	3	8	4	2	3
Oct.	1	4	3	3	3	8	3	3	3
Nov.	2	4	2	3	3	8	3	3	2
Dec.	2	3	3	3	2	9	4	3	2
Year	16	42	37	35	25	115	40	25	30

Month.	LEEWARDEN. Lat. 53° 12′. Long. 5° 47′. Height 24 ft. 35 Years, 1843–67. Hours A.M., Noon, P.M.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	4	5	6	8	2	2	...
Feb.	1	4	3	3	3	8	3	3	...
March	2	4	4	3	3	7	4	4	...
April	3	5	3	2	2	6	3	6	...
May	4	6	3	2	2	7	2	5	...
June	2	4	2	2	2	9	4	5	...
July	2	3	1	2	3	9	5	6	...
Aug.	2	3	2	3	4	9	3	5	...
Sept.	2	3	2	4	5	7	3	4	...
Oct.	1	4	4	5	5	7	2	3	...
Nov.	1	4	5	4	5	6	2	3	...
Dec.	1	3	3	4	6	9	3	2	...
Year	22	46	36	39	46	92	36	48	...

Month.	LUXEMBURG. Lat. 49° 37′. Long. 6° 8′. Height 1020 ft. 14 Years, 1870–83. Hours 8: 2, 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	3	4	5	8	3	2	...
Feb.	1	4	2	3	4	8	3	3	...
March	2	5	3	2	2	8	5	4	...
April	1	5	3	1	3	9	4	4	...
May	1	5	2	1	2	9	5	6	...
June	1	2	2	1	4	11	4	5	...
July	1	2	1	1	3	11	7	5	...
Aug.	1	2	2	1	4	11	6	4	...
Sept.	2	3	1	2	5	8	6	3	...
Oct.	1	4	2	2	5	8	5	4	...
Nov.	1	3	2	2	4	10	4	4	...
Dec.	3	4	2	1	4	9	4	4	...
Year	16	44	25	21	45	110	56	48	...

Month.	BRUSSELS. Lat. 50° 51′. Long. 4° 22′. Height 186 ft. 10 Years, 1853–62. Hours, 16 times daily.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	2	5	12	5	2	...
Feb.	1	3	4	2	3	7	5	3	...
March	2	3	4	2	3	8	6	3	...
April	3	5	4	1	2	6	5	4	...
May	3	4	4	2	2	7	5	4	...
June	2	2	1	1	2	11	8	3	...
July	2	2	1	1	2	11	8	4	...
Aug.	3	2	2	2	3	9	7	3	...
Sept.	2	3	2	2	4	10	5	2	...
Oct.	0	2	4	3	6	11	4	1	...
Nov.	1	3	5	3	5	8	4	1	...
Dec.	1	2	4	2	5	11	5	1	...
Year	21	33	37	23	42	111	67	31	...

Month.	STRASSBURG. Lat. 48° 36′. Long. 7° 42′. Height 460 ft. 15 Years? Hours?								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	1	2	11	4	1	3	...
Feb.	1	5	1	2	11	5	1	2	...
March	3	10	1	2	6	5	2	2	...
April	4	9	2	2	5	3	1	4	...
May	4	8	2	2	7	3	2	3	...
June	5	5	2	2	6	4	2	4	...
July	3	6	2	3	7	4	2	4	...
Aug.	4	5	2	4	7	4	2	3	...
Sept.	3	8	2	4	6	3	1	3	...
Oct.	2	9	2	3	9	3	1	2	...
Nov.	2	7	1	3	10	4	1	2	...
Dec.	2	6	1	2	13	4	1	2	...
Year	35	85	19	31	98	46	17	34	...

Month.	FÉCAMP. Lat. 49° 46′. Long. 0° 22′. Height 61 ft. 30 Years, 1853–82. Hour, Noon.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	C A
Jan.	1	2	5	3	5	6	6	3	...
Feb.	2	2	5	2	4	5	5	3	...
March	2	3	7	3	2	4	7	3	...
April	2	4	6	1	3	3	7	4	...
May	2	5	6	2	2	2	7	5	...
June	2	3	4	1	2	3	9	6	...
July	2	3	3	1	1	3	12	6	...
Aug.	2	3	4	1	2	4	10	5	...
Sept.	1	3	5	1	3	5	8	4	...
Oct.	2	2	4	4	5	5	6	3	...
Nov.	2	3	7	3	4	4	4	3	...
Dec.	2	2	5	3	5	5	5	4	...
Year	22	35	61	25	38	49	86	49	...

Month.	PARIS. Lat. 48° 50′. Long. 2° 20′. Height 216 ft. 30 Years, 1816–45. Hours various.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	3	5	6	4	3	1
Feb.	3	3	2	2	5	4	5	3	1
March	4	4	2	2	4	5	6	3	1
April	5	5	2	2	4	4	4	2	1
May	4	4	3	2	4	5	5	3	1
June	4	3	2	1	3	6	7	3	1
July	3	3	1	1	3	7	8	4	1
Aug.	3	3	2	1	3	7	8	3	1
Sept.	2	4	2	3	5	6	5	3	0
Oct.	2	3	2	3	6	6	5	3	1
Nov.	2	2	2	3	6	7	5	2	1
Dec.	2	4	2	3	5	7	5	3	0
Year	38	41	24	26	53	70	67	36	10

Month.	ST. HIPPOLYTE DE CATON. Lat. 47° 20′. Long. 6° 55′. Height 520 ft. 13 Years, 1837–49. Hours 9 : 2, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	13	7	0	0	4	1	1	5	...
Feb.	10	7	0	1	6	0	1	3	...
March	11	6	1	1	6	0	1	5	...
April	12	7	0	1	7	0	0	3	...
May	10	5	0	2	10	1	0	3	...
June	14	5	1	1	7	1	0	1	...
July	13	3	0	1	8	0	1	5	...
Aug.	11	5	0	1	7	1	1	5	...
Sept.	8	6	1	2	9	2	0	2	...
Oct.	10	7	1	1	6	1	1	4	...
Nov.	9	5	1	1	7	1	2	4	...
Dec.	11	7	0	1	5	1	1	5	...
Year	132	70	5	13	82	9	9	45	...

Month.	L'ORIENT. Lat. 47° 45′. Long. —3° 21′. Height 86 ft. 10 Years, 1862–71. Hours 9 : 3.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	4	4	3	7	4	2	...
Feb.	2	4	2	3	3	6	6	2	...
March	5	6	1	3	4	4	4	4	...
April	4	4	2	2	4	5	6	3	...
May	5	5	2	3	5	6	4	1	...
June	5	5	1	1	3	4	8	3	...
July	5	5	1	0	4	7	9	0	...
Aug.	4	4	1	1	3	7	8	3	...
Sept.	3	7	1	1	4	7	5	2	...
Oct.	3	5	3	3	4	5	5	3	...
Nov.	5	6	3	2	3	4	4	3	...
Dec.	4	5	3	3	3	6	3	4	...
Year	48	60	24	26	43	68	66	30	...

NANTES. Lat. 47° 13′. Long. –1° 33′. Height 136 ft. 4 Years, 1881–84. Hours 1, 4, 7, etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	4	4	4	5	3	1	1
Feb.	2	5	3	4	4	4	3	2	1
March	5	6	2	2	3	4	4	4	1
April	6	5	3	2	3	4	4	3	0
May	6	5	3	1	2	5	4	5	0
June	4	2	1	1	2	5	8	7	0
July	3	2	2	1	3	7	8	5	0
Aug.	4	3	2	1	2	6	8	5	0
Sept.	4	3	2	2	3	5	6	4	1
Oct.	6	3	3	2	3	5	5	4	0
Nov.	2	3	2	3	5	6	5	3	1
Dec.	3	4	2	3	4	5	6	3	1
Year	47	48	29	26	38	61	64	46	6

AHUN. Lat. 46° 6′. Long. 2° 0′. Height 1471 ft. 38 Years, 1828–65. Hours (?).

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	3	2	4	9	4	2	...
Feb.	3	5	3	1	4	6	3	3	...
March	4	7	2	1	3	6	5	3	...
April	4	5	3	1	3	6	5	3	...
May	5	6	1	1	3	6	5	4	...
June	4	5	2	1	2	7	5	4	...
July	4	6	1	1	1	7	6	5	...
Aug.	4	5	1	1	2	7	7	4	...
Sept.	3	6	3	1	3	8	3	3	...
Oct.	1	5	2	2	5	10	4	2	...
Nov.	3	5	3	2	4	8	3	2	...
Dec.	3	5	4	3	4	7	3	2	...
Year	41	64	28	17	38	87	53	37	...

PUY DE DÔME. Lat. 45° 46′. Long. 2° 57′. Height 4813 ft. 7 Years, 1878–84. Hours 3, 6, 9, etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	3	3	4	4	7	3	...
Feb.	2	2	2	2	5	5	7	3	...
March	4	4	4	2	4	4	6	3	...
April	3	4	2	2	4	4	6	5	...
May	2	6	3	3	3	4	7	3	...
June	3	4	2	2	2	4	9	4	...
July	2	2	2	2	2	6	11	4	...
Aug.	2	4	2	2	1	4	12	4	...
Sept.	2	4	2	2	3	5	8	4	...
Oct.	2	3	2	3	2	6	9	4	...
Nov.	2	2	2	2	3	6	10	3	...
Dec.	2	4	3	2	2	5	9	4	...
Year	30	42	29	27	35	57	101	44	...

PIC DU MIDI. Lat. 42° 57′. Long. –0° 22′. Height 9380 ft. 7 Years, 1878–84. Hours, 5 times daily.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	2	1	1	4	5	6	3
Feb.	2	4	1	1	1	7	5	5	2
March	4	4	2	1	1	6	3	6	4
April	3	3	1	1	2	8	4	6	2
May	2	4	1	1	2	9	5	2	5
June	1	3	0	0	2	12	5	4	3
July	2	2	0	1	2	12	7	2	3
Aug.	1	1	0	1	2	9	7	5	5
Sept.	2	2	1	1	1	9	6	5	3
Oct.	2	3	1	0	1	9	5	6	4
Nov.	2	3	1	1	1	6	5	7	4
Dec.	2	4	2	1	1	3	5	7	6
Year	27	38	12	10	17	94	62	61	44

TOULOUSE. Lat. 43° 37′. Long. 1° 28′. Height 650 ft. 22 Years, 1839–60. Hours 9, N.: 3, 6, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	0	8	2	3	9	8	...
Feb.	1	1	0	9	2	2	7	6	...
March	2	1	0	9	2	2	6	9	...
April	1	1	1	11	1	1	7	7	...
May	2	2	1	9	2	2	6	7	...
June	2	1	1	9	2	1	5	9	...
July	4	1	0	5	1	1	7	12	...
Aug.	4	0	1	6	1	2	6	11	...
Sept.	2	1	0	7	3	3	5	9	...
Oct.	2	1	1	9	3	2	6	7	...
Nov.	1	1	1	10	2	3	6	6	...
Dec.	1	0	1	11	3	3	6	6	...
Year	23	10	7	103	24	25	76	97	...

PAU. Lat. 43° 18′. Long. –0° 20′. Height 700 ft. 16 Years, 1854–69. Hour 9:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	14	3	1	7	2	...
Feb.	1	1	2	13	2	1	5	3	...
March	1	1	2	9	2	2	9	5	...
April	2	1	2	8	1	1	10	5	...
May	2	1	2	6	3	2	9	6	...
June	4	1	5	4	1	0	7	8	...
July	2	3	4	3	1	1	10	7	...
Aug.	2	2	4	6	0	3	9	5	...
Sept.	1	1	6	10	2	1	6	3	...
Oct.	2	1	2	12	3	1	7	3	...
Nov.	2	3	2	12	2	1	6	2	...
Dec.	1	1	1	15	4	2	5	2	...
Year	22	17	33	112	24	16	90	51	...

BORDEAUX. Lat. 44° 50′. Long. –0° 31′. Height ? 10 Years, 1837–46. Hours 7, N.: 2, 6, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	6	3	4	4	5	5	...
Feb.	3	1	6	2	3	4	5	4	...
March	2	2	6	2	3	4	7	5	...
April	1	1	6	2	1	3	10	6	...
May	1	1	4	2	1	4	11	7	...
June	0	1	5	1	1	4	12	6	...
July	1	1	3	0	1	4	16	5	...
Aug.	1	1	4	1	1	4	13	6	...
Sept.	1	1	6	2	3	5	8	4	...
Oct.	1	1	7	2	2	4	6	8	...
Nov.	1	1	6	5	5	5	4	3	...
Dec.	2	2	7	5	2	4	2	7	...
Year	17	14	66	27	27	49	99	66	...

PERPIGNAN. Lat. 42° 42′. Long. 2° 54′. Height 102 ft. 15 Years, 1870–84. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	3	2	1	2	7	8	1
Feb.	4	2	2	3	2	2	6	7	0
March	4	2	3	3	2	2	5	9	1
April	4	3	3	3	2	2	5	7	1
May	4	4	5	3	1	2	5	6	1
June	4	3	4	3	1	2	5	8	0
July	4	4	4	3	2	2	4	7	1
Aug.	3	3	5	3	2	3	5	5	2
Sept.	4	3	5	3	3	2	4	5	1
Oct.	3	2	4	3	2	2	5	8	2
Nov.	3	4	2	2	2	3	5	8	1
Dec.	4	6	6	3	2	1	3	5	1
Year	46	38	46	34	22	25	59	83	12

MARSEILLES. Lat. 43° 17′. Long. 5° 22′. Height 246 ft. 7 Years, 1878–84. Hours 7, 10: 1, 4, 7, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	6	6	2	0	1	3	9	3
Feb.	1	5	6	4	1	1	3	6	1
March	1	5	4	3	1	2	4	8	3
April	0	3	4	4	1	2	6	8	2
May	1	3	4	3	2	3	6	7	2
June	0	2	3	2	1	3	9	8	2
July	0	4	2	2	2	3	7	8	3
Aug.	0	3	3	1	1	4	8	8	3
Sept.	0	5	4	2	1	3	6	7	2
Oct.	0	5	3	2	2	2	4	8	5
Nov.	0	5	5	2	1	1	3	9	4
Dec.	1	5	4	2	0	1	3	11	4
Year	5	51	48	29	13	26	62	97	34

AJACCIO. Lat. 41° 55′. Long. 8° 44′. Height 60 ft. 2 Years, 1880–81. Hours (?).

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	3	1	2	4	3	3	3	6
Feb.	3	2	0	3	3	1	2	3	11
March	6	3	1	2	6	3	2	3	5
April	3	1	1	1	3	2	3	2	14
May	2	1	1	3	2	5	1	1	15
June	2	1	1	2	3	5	1	2	13
July	5	1	2	3	8	5	3	2	2
Aug.	1	1	0	0	5	7	2	0	15
Sept.	7	3	3	3	5	4	3	2	0
Oct.	7	4	1	3	4	4	3	3	2
Nov.	6	3	1	2	6	3	2	3	4
Dec.	6	6	2	3	2	3	2	2	5
Year	54	29	14	27	51	45	27	26	92

SÄNTIS. Lat. 47° 15′. Long. —9° 20′. Height 8094 ft. 5 Years, 1882–87. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	3	2	1	6	8	2	6
Feb.	0	1	1	1	3	7	7	3	5
March	1	1	2	3	3	7	8	3	3
April	1	1	2	3	3	7	5	2	6
May	1	1	3	1	4	7	8	3	3
June	2	2	1	1	2	4	8	4	6
July	1	1	1	0	2	6	10	3	7
Aug.	1	1	1	1	1	7	11	2	6
Sept.	0	0	1	1	3	8	8	2	7
Oct.	0	1	1	1	4	8	9	3	4
Nov.	1	1	1	0	3	7	9	3	5
Dec.	1	2	1	1	2	8	10	3	3
Year	10	14	18	15	31	82	101	33	61

GENEVA. Lat. 46° 12′. Long. 6° 9′. Height 1335 ft. 35 Years, 1826–60. Two hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	4	2	2	3	13	1	1	...
Feb.	7	6	1	1	3	8	1	1	...
March	9	7	1	0	2	10	1	1	...
April	10	6	0	1	1	10	1	1	...
May	10	7	1	0	1	10	1	1	...
June	9	8	0	0	1	10	1	1	...
July	10	5	1	0	1	11	1	2	...
Aug.	10	5	0	1	2	10	1	2	...
Sept.	8	6	0	1	1	12	1	1	...
Oct.	10	7	0	1	1	10	1	1	...
Nov.	5	6	1	2	2	12	1	1	...
Dec.	8	6	2	2	3	8	1	1	...
Year	101	73	9	11	21	124	12	14	...

BILBAO. Lat. 43° 15′. Long. —2° 56′. Height 52 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	13	1	3	1	8	...
Feb.	1	1	2	9	2	4	2	7	...
March	3	4	1	5	1	2	1	14	...
April	1	2	1	5	1	2	1	17	...
May	1	2	1	4	1	1	1	20	...
June	1	1	1	5	1	0	1	20	...
July	1	3	2	4	0	1	1	19	...
Aug.	1	4	1	5	1	1	1	17	...
Sept.	1	2	2	6	1	2	2	14	...
Oct.	1	2	2	7	2	3	2	12	...
Nov.	2	2	2	9	2	4	1	8	...
Dec.	2	2	2	11	2	3	2	7	...
Year	16	27	19	83	15	26	16	163	...

CORUNNA. Lat. 43° 22′. Long. —8° 25′. Height 82 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	9	0	0	4	9	2	5	...
Feb.	1	9	0	1	2	10	1	4	...
March	2	13	2	1	1	6	2	4	...
April	2	9	0	0	1	9	3	6	...
May	3	13	1	1	1	4	1	7	...
June	2	12	0	0	1	7	2	6	...
July	4	12	0	0	0	6	2	7	...
Aug.	3	11	0	0	1	9	1	6	...
Sept.	2	10	0	0	1	9	2	6	...
Oct.	3	8	0	1	3	10	1	5	...
Nov.	2	11	0	1	2	8	2	4	...
Dec.	3	12	1	0	3	7	1	4	...
Year	29	129	4	5	20	94	20	64	...

OPORTO. Lat. 41° 9′. Long. —8° 29′. Height 279 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	6	6	4	6	2	2	...
Feb.	3	2	4	4	4	7	2	2	...
March	4	4	4	3	2	6	4	4	...
April	3	1	1	1	2	7	8	7	...
May	5	2	1	1	1	7	7	7	...
June	4	1	1	1	1	4	10	8	...
July	6	1	0	0	0	4	10	10	...
Aug.	5	0	1	0	0	7	11	7	...
Sept.	4	1	1	1	2	8	7	6	...
Oct.	3	2	2	3	3	7	6	5	...
Nov.	3	1	5	5	3	6	4	3	...
Dec.	2	3	8	9	3	3	1	2	...
Year	45	20	34	34	25	72	72	63	...

COIMBRA. Lat. 40° 12′. Long. —8° 30′. Height 463 ft. 12 Years, 1876–87. Two hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	6	8	4	1	2	4	2
Feb.	2	1	3	5	4	2	3	6	2
March	4	1	4	4	3	1	3	9	2
April	2	1	2	3	2	2	6	10	2
May	2	1	2	2	3	2	5	11	3
June	2	1	1	1	2	1	6	13	3
July	2	0	1	0	1	0	6	18	3
Aug.	2	0	0	1	1	1	7	15	4
Sept.	2	1	1	2	1	1	5	13	4
Oct.	2	1	3	5	3	2	3	9	3
Nov.	3	1	4	6	4	2	2	6	2
Dec.	3	2	6	7	4	1	2	4	2
Year	29	11	33	44	32	16	50	118	32

LISBON. Lat. 38° 42′. Long. —9° 8′. Height 335 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	6	1	1	3	3	3	4	...
Feb.	8	3	1	1	3	5	3	4	...
March	11	4	1	1	2	4	3	5	...
April	9	1	0	0	2	5	5	8	...
May	13	1	1	0	2	5	3	6	...
June	15	1	0	0	0	4	3	7	...
July	21	0	0	0	0	2	2	6	...
Aug.	16	0	0	0	0	5	3	7	...
Sept.	14	1	0	0	2	5	3	5	...
Oct.	11	3	1	0	3	6	3	4	...
Nov.	9	6	1	1	2	4	3	4	...
Dec.	11	8	1	1	2	4	1	3	...
Year	148	34	7	5	21	52	35	63	...

SALAMANCA. Lat. 40° 58′. Long. —5° 41′. Height 2671 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	6	4	1	3	4	9	...
Feb.	2	2	5	2	1	5	4	7	...
March	2	2	6	5	1	3	4	8	...
April	2	3	4	2	1	3	4	11	...
May	2	3	4	5	1	4	3	9	...
June	1	3	3	3	1	3	3	13	...
July	3	4	3	2	1	3	3	12	...
Aug.	3	4	1	3	0	3	3	14	...
Sept.	2	3	3	3	2	4	4	9	...
Oct.	1	3	3	5	1	4	7	7	...
Nov.	1	1	5	6	1	5	4	7	...
Dec.	2	4	6	5	0	4	4	6	...
Year	23	34	49	45	11	44	47	112	...

ZARAGOZA. Lat. 41° 38′. Long. —0° 54′. Height 656 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	2	1	7	1	0	1	19	...
Feb.	0	1	0	5	1	1	1	19	...
March	0	1	0	6	0	1	1	22	...
April	0	1	0	6	1	1	1	20	...
May	0	1	0	6	1	1	1	21	...
June	0	2	0	5	0	1	1	21	...
July	0	2	0	7	0	1	1	20	...
Aug.	0	2	1	7	0	1	1	19	...
Sept.	1	3	1	6	1	1	1	16	...
Oct.	1	1	1	8	0	1	1	18	...
Nov.	1	2	0	7	0	1	2	17	...
Dec.	0	1	0	8	0	0	1	21	...
Year	3	19	4	78	5	10	13	233	...

BARCELONA. Lat. 41° 23′. Long. 2° 9′. Height 49 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	3	1	2	5	10	4	...
Feb.	1	3	2	2	4	7	6	3	...
March	1	3	5	4	6	8	3	1	...
April	1	2	5	5	5	7	4	1	...
May	0	2	7	5	6	8	2	1	...
June	0	1	6	7	9	6	1	0	...
July	0	1	6	7	10	6	1	0	...
Aug.	0	1	5	8	10	6	1	0	...
Sept.	1	4	6	6	6	6	1	0	...
Oct.	1	4	5	4	4	7	5	1	...
Nov.	2	3	3	2	3	4	8	5	...
Dec.	4	4	1	0	1	4	9	8	...
Year	13	32	54	51	66	74	51	24	...

MADRID. Lat. 40° 24′. Long. —3° 42′. Height 2149 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	11	3	2	2	5	2	3	...
Feb.	2	7	3	2	2	6	3	3	...
March	3	9	3	4	2	5	3	2	...
April	3	5	2	2	2	6	5	5	...
May	2	8	3	3	2	6	4	3	...
June	2	7	3	3	2	6	4	3	...
July	3	8	2	3	2	6	5	2	...
Aug.	2	9	3	3	1	5	4	4	...
Sept.	1	8	3	4	2	7	3	2	...
Oct.	2	8	3	3	2	7	3	3	...
Nov.	3	8	3	2	2	6	3	3	...
Dec.	3	12	4	2	2	4	2	2	...
Year	29	100	35	33	23	69	41	35	...

VALENCIA. Lat. 39° 28′. Long. —0° 23. Height 59 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	1	0	1	4	14	6	...
Feb.	3	2	0	0	1	4	13	5	...
March	5	3	2	1	1	3	11	5	...
April	4	4	2	1	1	2	12	4	...
May	3	7	5	2	1	2	8	3	...
June	2	6	7	3	1	2	7	2	...
July	3	6	7	5	1	1	4	4	...
Aug.	3	6	5	3	1	1	6	6	...
Sept.	5	4	3	3	1	1	8	5	...
Oct.	4	2	1	1	1	3	13	6	...
Nov.	2	2	1	0	0	3	16	6	...
Dec.	3	2	1	0	1	4	14	6	...
Year	41	45	35	19	11	30	126	58	...

ALICANTE. Lat. 38° 21′. Long. — 0° 30′. Height 46 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	2	1	7	2	12	...
Feb.	1	4	2	4	2	4	1	10	...
March	1	6	3	6	4	5	1	5	...
April	1	3	3	7	5	3	1	7	...
May	0	5	3	11	4	4	1	3	...
June	0	3	4	13	5	2	1	2	...
July	0	2	4	17	5	1	1	1	...
Aug.	0	2	4	16	5	2	1	1	...
Sept.	0	6	3	12	4	2	0	3	...
Oct.	1	6	2	8	4	4	1	5	...
Nov.	1	5	1	4	3	5	2	9	...
Dec.	3	5	1	1	1	5	2	13	...
Year	10	51	31	101	43	44	14	71	...

PALMA. Lat. 39° 33′. Long. 2° 37′. Height 66 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	1	1	2	7	3	7	...
Feb.	4	4	1	1	4	8	3	3	...
March	3	5	2	1	5	10	2	3	...
April	2	4	2	1	6	10	2	3	...
May	1	4	2	1	8	12	1	2	...
June	1	3	2	1	8	14	0	1	...
July	1	3	2	1	9	14	0	1	...
Aug.	1	2	1	1	11	13	1	1	...
Sept.	2	4	2	0	6	13	1	2	...
Oct.	3	5	2	0	4	10	2	5	...
Nov.	5	4	1	1	1	7	5	6	...
Dec.	8	4	1	1	2	5	4	6	...
Year	36	47	19	10	66	123	24	40	...

SEVILLE. Lat. 37° 23′. Long. —6° 1′. Height 98 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	12	2	2	1	5	1	5	...
Feb.	2	6	1	2	1	11	1	4	...
March	2	9	2	4	3	8	1	2	...
April	1	5	1	2	2	14	1	4	...
May	0	5	1	2	1	18	1	3	...
June	1	3	1	1	1	20	0	3	...
July	1	1	1	2	3	20	1	2	...
Aug.	1	1	1	2	3	21	1	1	...
Sept.	1	2	2	2	2	18	1	2	...
Oct.	1	5	2	3	2	12	2	4	...
Nov.	1	10	2	2	3	7	1	4	...
Dec.	1	13	1	1	1	8	1	5	...
Year	15	72	17	25	23	162	12	39	...

GIBRALTAR. Lat. 36° 6′. Long. —5° 20′. Height 53 ft. 15 Years, 1870–84. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	10	1	1	2	6	6	...
Feb.	2	2	7	1	0	2	8	6	...
March	1	3	12	2	0	2	7	4	...
April	1	2	7	1	0	4	11	4	...
May	0	4	10	1	0	3	9	4	...
June	0	4	8	1	0	5	10	2	...
July	0	5	12	0	0	4	8	2	...
Aug.	0	5	12	1	0	5	7	1	...
Sept.	0	5	10	1	0	3	8	3	...
Oct.	1	4	10	0	1	4	7	4	...
Nov.	2	5	8	0	0	3	7	5	...
Dec.	2	3	9	1	0	3	6	7	...
Year	12	44	115	10	2	40	94	48	...

TARIFA. Lat. 36° 0′. Long. —5° 35′. Height 46 ft. 11 Years, 1870–80. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	11	1	2	3	6	6	...
Feb.	0	1	10	1	1	3	7	5	...
March	0	0	14	1	2	3	8	3	...
April	0	0	10	1	1	2	12	4	...
May	0	0	15	0	1	3	10	2	...
June	0	0	11	0	1	1	16	1	...
July	0	0	16	0	0	1	13	1	...
Aug.	0	0	16	0	0	0	14	1	...
Sept.	0	0	16	0	0	1	11	2	...
Oct.	0	0	13	1	2	2	10	3	...
Nov.	1	0	10	2	1	4	7	5	...
Dec.	1	0	11	1	1	4	5	8	...
Year	4	1	153	8	12	27	119	41	...

Month.	VENICE. Lat. 45° 26′. Long. 12° 20. Height 69 ft. 13 Years, 1853–66. Hours 6: 2, 10.									BOLOGNA. Lat. 44° 30′. Long. 11° 20′. Height ? 45 Years, 1814–58. Hour?									NICE. Lat. 43° 42′. Long. 7° 17′. Height 89 ft. 30 Years, 1849–78. Hours, various.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	6	2	2	1	2	2	5	1	1	1	1	0	1	2	19	6	...	6	1	7	4	4	7	1	1	...
Feb.	6	8	3	2	2	2	1	3	1	1	1	2	1	1	2	14	6	...	2	1	8	5	4	7	1	0	...
March	3	8	5	5	3	2	2	1	2	2	2	4	2	1	3	11	6	...	2	1	10	5	6	6	0	1	...
April	2	5	4	6	6	2	1	2	2	2	2	7	2	2	3	7	5	...	0	2	11	7	7	3	0	0	...
May	2	5	4	7	7	3	1	1	1	3	3	6	2	3	3	7	4	...	1	0	8	9	7	6	0	0	...
June	3	4	4	6	7	2	1	1	2	2	3	6	2	2	4	7	4	...	0	0	8	10	7	5	0	0	...
July	4	5	4	6	5	2	1	2	2	3	2	7	3	1	2	8	5	...	0	0	6	12	7	5	1	0	...
Aug.	3	6	4	6	6	2	1	1	2	2	2	7	3	2	2	8	5	...	0	0	6	12	7	5	1	0	...
Sept.	4	7	5	5	4	2	1	2	0	2	2	6	2	2	3	9	4	...	1	1	7	9	6	6	0	0	...
Oct.	6	7	3	3	3	4	2	3	0	2	1	4	2	2	3	12	5	...	1	2	9	5	6	7	1	0	...
Nov.	8	9	3	2	2	1	1	3	1	2	1	2	1	1	2	16	5	...	4	2	7	4	5	7	1	0	...
Dec.	9	8	3	2	1	2	1	6	1	1	1	2	1	1	0	20	5	...	7	1	7	3	4	7	1	1	...
Year	60	78	44	52	47	24	15	30	15	23	21	54	21	19	29	138	60	...	24	11	94	85	70	71	7	3	...

Month.	ROME. Lat. 41° 54′. Long. 12° 28′. Height 102 ft. 16 Years, 1862–77. Four times daily.									NAPLES. Lat. 40° 52′. Long. 14° 15′. Height 489 ft. 28 Years, 1833–60. Hours 9, N.: 9.									PALERMO. Lat. 38° 7′. Long. 13° 21′. Height 236 ft. 12 Years, 1866–77. Six times daily.								
	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	18	2	2	1	5	1	1	1	...	7	8	1	2	4	5	1	3	...	2	3	2	1	2	14	5	2	...
Feb.	14	1	2	1	5	1	3	1	...	5	6	1	2	3	6	2	3	...	2	4	2	1	1	8	9	1	...
March	11	1	2	1	9	2	4	1	...	5	6	1	2	4	8	2	3	...	2	5	2	1	1	8	9	3	...
April	8	1	1	1	8	4	6	1	...	3	5	1	2	5	10	2	2	...	2	6	3	1	1	6	8	3	...
May	8	1	1	1	9	4	6	1	...	3	4	1	2	6	11	2	2	...	1	12	4	1	0	4	7	2	...
June	7	1	1	0	7	5	8	1	...	2	3	1	3	5	11	2	3	...	2	14	4	0	0	4	4	2	...
July	6	0	1	0	7	5	11	1	...	1	3	1	3	6	11	3	3	...	2	14	4	0	0	5	5	1	...
Aug.	8	1	1	0	8	4	8	1	...	2	4	1	2	5	11	3	3	...	2	11	4	0	0	7	5	2	...
Sept.	9	1	1	0	7	5	6	1	...	4	5	1	2	5	8	2	3	...	2	11	4	0	0	6	6	1	...
Oct.	12	1	2	1	8	2	4	1	...	5	5	1	2	5	8	2	3	...	1	6	3	1	1	7	10	2	...
Nov.	15	1	3	1	7	1	2	0	...	7	6	1	2	4	6	2	2	...	1	3	1	1	1	9	12	2	...
Dec.	20	1	2	1	5	1	1	0	...	8	8	1	1	3	4	2	4	...	1	4	1	1	1	10	11	2	...
Year	136	12	19	8	85	35	60	10	...	52	63	12	25	55	99	25	34	...	20	93	34	8	8	88	91	23	...

Month.	MALTA. Lat. 35° 53′. Long. 14° 30′. Height 70 ft. 15 Years, 1870–84. Hours 9: 3.									CORFU. Lat. 39° 38′. Long. 19° 33′. Height 98 ft. 11 Years, 1869–79. Hours 7: 2, 10.									JANINA. Lat. 39° 47′. Long. 20° 57′. Height 1580 ft. 8 Years, 1866–73. Hours 9: 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	5	1	5	0	4	2	10	2	1	1	5	7	1	1	3	3	9	3	9	2	7	3	1	3	3	...
Feb.	1	6	1	4	1	4	2	9	0	1	1	3	8	1	2	2	3	7	2	8	2	6	3	2	2	3	...
March	1	6	1	5	1	3	3	10	1	1	1	2	8	1	2	3	4	9	2	4	3	7	5	2	5	3	...
April	1	4	1	5	1	3	2	12	1	1	1	1	7	2	2	3	3	10	4	5	1	5	6	2	2	5	...
May	2	7	2	6	0	2	1	10	1	1	1	1	6	2	1	3	4	12	2	7	1	5	4	4	2	6	...
June	2	9	2	4	0	1	1	10	1	2	1	1	5	1	1	3	5	11	3	4	1	4	3	4	2	9	...
July	3	9	1	3	0	1	1	12	1	2	1	1	3	1	1	3	7	12	3	6	2	2	4	3	2	9	...
Aug.	2	9	2	3	0	2	1	11	1	1	1	1	3	1	1	4	6	13	4	4	2	1	1	2	2	15	...
Sept.	2	6	2	5	1	3	1	10	0	2	1	1	4	1	2	3	4	12	4	5	2	5	1	0	2	11	...
Oct.	1	6	1	7	1	3	2	10	0	3	1	2	8	2	2	2	2	9	4	6	2	9	3	1	1	5	...
Nov.	1	5	1	5	1	3	2	11	1	1	1	3	8	2	2	3	3	7	2	7	1	10	2	1	1	6	...
Dec.	1	5	1	5	0	5	3	10	1	1	1	3	7	2	2	3	3	9	2	7	2	11	2	1	2	4	...
Year	19	77	16	57	6	34	21	125	10	17	12	24	74	17	19	35	47	120	35	72	21	72	37	23	26	79	...

CANDIA. Lat. 35° 30′. Long. 24° 0′. Height 112 ft. $6\frac{1}{3}$ Years, 1879–85. Hours 8 : 2 ; $8\frac{1}{4}$: $1\frac{3}{4}$, $9\frac{3}{4}$.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	3	2	5	2	3	1	6
Feb.	4	6	3	2	2	1	2	1	7
March	3	3	3	4	2	3	4	1	8
April	2	2	4	2	2	2	5	3	8
May	3	2	4	2	2	1	7	3	7
June	2	3	3	2	2	1	7	3	7
July	2	4	1	2	1	1	4	7	9
Aug.	3	6	1	1	2	1	4	6	7
Sept.	5	3	2	1	2	1	4	3	9
Oct.	2	4	2	1	2	2	4	1	13
Nov.	3	5	4	1	2	2	3	1	9
Dec.	3	3	3	2	2	2	4	1	11
Year	34	48	33	22	26	19	51	31	101

ATHENS. Lat. 37° 58′. Long. 23° 44′. Height 337 ft. 23 Years, 1859–82. Once daily.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	10	1	1	4	7	2	2	...
Feb.	2	8	1	2	3	7	3	2	...
March	2	6	1	1	5	11	3	2	...
April	1	6	1	1	3	13	4	1	...
May	1	6	1	1	4	14	3	1	...
June	1	8	0	1	3	13	2	2	...
July	1	14	0	1	2	11	2	0	...
Aug.	1	14	1	1	2	9	2	1	...
Sept.	2	11	1	1	3	10	1	1	...
Oct.	2	9	0	1	4	12	2	1	...
Nov.	2	9	1	1	5	8	3	1	...
Dec.	3	8	1	1	4	8	4	2	...
Year	22	109	9	13	42	123	31	16	...

LARNACA. Lat. 34° 57′. Long. 33° 39′. Height 25 ft. 4 Years, 1866–70. Hour 9 :

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	4	1	2	3	3	5	7	0
Feb.	7	4	0	0	2	4	4	6	1
March	3	5	2	2	5	7	3	3	1
April	4	3	5	3	3	5	3	4	0
May	4	7	7	4	6	1	0	2	0
June	11	1	1	5	3	3	0	5	1
July	3	1	1	4	5	15	1	1	0
Aug.	2	2	5	4	6	9	1	0	2
Sept.	7	2	2	2	9	5	0	2	1
Oct.	4	3	3	3	6	5	1	5	1
Nov.	6	3	1	2	4	6	4	4	0
Dec.	6	3	2	1	1	7	4	6	1
Year	63	38	30	32	53	70	26	45	8

CONSTANTINOPLE. Lat. 41° 0′. Long. 28° 59′. Height ? 8 Years, 1868–75. Hour 9 :

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	7	0	2	4	6	0	3	...
Feb.	8	9	0	2	3	5	0	1	...
March	8	10	0	1	6	4	0	2	...
April	6	9	0	1	6	6	0	2	...
May	6	12	0	1	7	4	0	1	...
June	5	14	0	1	5	3	0	2	...
July	6	18	0	0	3	2	0	2	...
Aug.	6	18	0	0	3	2	0	2	...
Sept.	6	13	0	1	3	3	0	4	...
Oct.	6	12	0	0	5	6	0	2	...
Nov.	5	6	0	2	6	9	0	2	...
Dec.	6	6	1	2	3	11	0	2	...
Year	77	134	1	13	54	61	0	25	...

BUCHAREST. Lat. 44° 25′. Long. 26° 5′. Height 305 ft. 14 Years, 1871–84. Hours 6 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	6	5	1	2	5	7	2	2
Feb.	2	5	5	1	1	5	6	2	1
March	1	6	6	1	2	4	6	3	2
April	2	6	7	2	1	3	4	3	2
May	2	5	7	2	2	3	5	2	3
June	3	5	5	2	1	3	6	3	2
July	3	6	5	2	1	3	5	3	3
Aug.	4	6	7	1	1	2	4	3	3
Sept.	3	7	6	2	1	2	5	2	2
Oct.	3	7	7	1	1	3	5	2	2
Nov.	2	5	5	1	2	4	6	3	2
Dec.	2	5	5	1	2	5	7	2	2
Year	28	69	70	17	17	42	66	30	26

BRAILA. Lat. 45° 6′. Long. 27° 59. Height 71 ft. 2 Years, 1879–80. Hours 6, 9, N.: 3, 6, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	6	2	2	4	2	1	5	1
Feb.	2	4	2	5	9	4	0	0	2
March	8	6	2	2	5	2	1	4	1
April	4	5	4	4	6	3	1	1	2
May	4	5	4	5	6	1	1	2	3
June	4	4	4	4	6	3	1	2	2
July	6	3	2	5	5	4	2	2	2
Aug.	5	4	2	6	6	1	1	3	3
Sept.	4	5	3	5	3	1	0	6	3
Oct.	3	6	2	4	5	5	0	4	2
Nov.	3	5	1	3	5	6	0	4	3
Dec.	6	6	1	4	7	4	1	2	0
Year	57	59	29	49	67	36	9	35	24

HERMANNSTADT. Lat. 45° 47′ Long. 24° 9′. Height 1381 ft. 10 Years, 1875–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	0	4	7	3	1	5	7	1
Feb.	3	0	4	5	5	1	3	6	1
March	5	1	3	6	5	1	2	8	0
April	3	1	4	7	5	1	2	6	1
May	4	1	3	5	5	1	3	8	1
June	3	1	3	5	4	2	3	8	1
July	4	1	2	4	4	1	6	8	1
Aug.	4	1	5	4	4	1	6	6	0
Sept.	3	1	3	6	6	1	2	7	1
Oct.	2	1	3	8	5	1	3	7	1
Nov.	2	1	4	6	6	1	4	6	0
Dec.	3	2	3	7	5	1	4	6	0
Year	39	11	41	70	57	13	43	83	8

ORSOVA. Lat. 44° 42′. Long. 22° 25′. Height 174 ft. 10 Years, 1875–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	1	0	2	1	1	4	16
Feb.	3	1	0	0	1	1	1	4	17
March	3	1	1	0	2	1	1	4	18
April	2	2	1	1	2	1	1	3	17
May	2	1	1	1	2	1	1	5	17
June	2	1	0	0	2	1	2	4	18
July	2	0	0	0	2	1	1	6	19
Aug.	2	1	0	0	2	1	1	4	20
Sept.	2	1	1	1	1	0	1	3	20
Oct.	3	2	1	1	1	1	1	2	19
Nov.	3	1	0	0	1	0	1	4	20
Dec.	3	1	1	1	1	0	1	3	20
Year	32	13	7	5	19	9	13	46	221

BUDAPEST. Lat. 47° 30′. Long. 19° 2′. Height 502 ft. 10 Years, 1875–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	2	1	1	1	8	3	9
Feb.	3	1	3	1	1	1	8	2	8
March	2	2	2	1	2	2	10	4	6
April	4	2	3	1	2	1	7	3	7
May	4	2	2	1	2	2	8	3	7
June	3	1	2	1	1	2	11	3	6
July	2	1	2	1	1	1	12	4	7
Aug.	3	1	2	0	1	1	10	4	9
Sept.	2	2	2	1	1	1	8	4	9
Oct.	3	2	3	1	1	1	6	5	9
Nov.	2	2	3	1	1	1	6	4	10
Dec.	4	2	2	2	1	1	6	3	10
Year	36	20	28	12	15	15	100	42	97

SZEGEDIN. Lat. 46° 15′. Long. 20° 9′. Height 289 ft. 10 Years, 1875–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	2	6	1	2	3	11
Feb.	2	1	1	2	7	2	2	2	9
March	3	1	1	2	7	2	3	3	9
April	2	1	1	2	7	2	2	3	10
May	4	1	1	2	5	2	3	4	9
June	3	1	2	1	5	3	3	2	10
July	4	2	1	1	4	2	3	2	12
Aug.	1	1	1	1	3	2	3	4	15
Sept.	3	0	1	2	6	2	1	2	13
Oct.	2	1	1	2	6	2	3	2	12
Nov.	3	1	1	2	7	2	1	2	11
Dec.	3	0	1	2	7	1	2	2	13
Year	33	11	14	21	70	23	28	31	134

DEBRECZIN. Lat. 47° 31′. Long. 21° 38′. Height 453 ft. 10 Years, 1875–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	4	3	1	5	7	2	2	1
Feb.	5	3	2	1	6	6	2	2	1
March	6	4	3	1	6	4	3	2	2
April	7	4	3	2	4	4	2	2	2
May	7	4	4	1	4	5	2	2	2
June	5	3	3	1	5	6	3	2	2
July	6	3	3	1	4	6	4	2	2
Aug.	6	4	2	1	6	5	3	2	2
Sept.	6	4	2	2	6	4	2	2	2
Oct.	5	4	3	1	6	6	3	2	1
Nov.	5	3	3	2	6	6	2	2	1
Dec.	5	4	2	2	5	8	2	2	1
Year	69	44	33	16	63	67	30	24	19

PRAGUE. Lat. 50° 5′. Long. 14° 25′. Height 660 ft. 33 Years, 1852–84. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	3	2	5	6	7	3	1
Feb.	2	2	2	2	4	6	6	3	1
March	3	2	3	2	4	5	7	4	1
April	4	3	3	2	3	4	6	4	1
May	4	3	3	2	3	4	5	5	2
June	3	2	2	2	2	5	7	5	2
July	2	2	1	2	3	6	8	5	2
Aug.	3	2	2	2	4	6	7	4	1
Sept.	2	2	3	2	4	5	7	4	1
Oct.	2	2	3	2	5	6	7	2	2
Nov.	2	1	3	3	5	6	6	3	1
Dec.	2	2	3	2	5	6	7	3	1
Year	31	25	31	25	47	65	80	45	16

LESINA. Lat. 43° 11′. Long. 16° 27′. Height 34 ft. 15 Years, 1870–84. Hours 7 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	4	8	5	1	0	1	4	1
Feb.	5	3	7	5	1	1	1	4	1
March	5	4	7	6	2	1	2	3	1
April	3	3	6	7	2	1	2	3	3
May	3	2	5	7	2	1	3	5	3
June	4	1	4	5	3	1	3	6	3
July	5	3	3	4	2	0	4	7	3
Aug.	4	3	3	4	3	0	4	6	4
Sept.	5	3	5	5	2	1	3	4	2
Oct.	5	3	8	7	2	1	1	3	1
Nov.	5	3	7	6	3	1	1	3	1
Dec.	6	4	8	6	2	0	1	3	1
Year	57	36	71	67	25	8	26	51	24

POLA. Lat. 44° 52′. Long. 13° 50′. Height 105 ft. 15 Years, 1870–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	7	3	1	1	2	4	4
Feb.	3	4	7	4	1	1	2	3	3
March	2	4	8	5	3	1	2	3	3
April	1	3	7	7	3	2	2	2	3
May	2	2	7	6	3	2	2	3	4
June	2	2	5	6	3	2	3	3	4
July	2	2	5	5	3	2	3	4	5
Aug.	2	3	7	4	2	2	3	3	5
Sept.	2	3	8	5	2	2	3	2	3
Oct.	2	4	8	5	3	2	2	2	3
Nov.	3	5	7	4	2	2	2	2	3
Dec.	3	6	7	3	2	1	2	3	4
Year	28	43	83	57	28	20	28	34	44

TRIEST. Lat. 45° 39′. Long. 13° 46′. Height 85 ft. 15 Years, 1870–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	6	9	2	1	1	1	1	10
Feb.	0	5	6	2	1	1	2	1	10
March	1	6	7	2	1	1	2	2	9
April	1	4	7	2	1	2	3	2	8
May	1	5	7	2	1	2	3	3	7
June	1	3	7	2	1	2	4	3	7
July	1	4	7	2	1	2	4	2	8
Aug.	1	5	7	2	1	2	3	2	8
Sept.	0	4	9	2	1	1	3	2	8
Oct.	1	6	9	3	1	1	1	1	8
Nov.	0	6	9	3	1	1	1	1	8
Dec.	0	7	8	2	1	1	1	1	10
Year	7	61	92	26	12	17	28	21	101

LEMBERG. Lat. 49° 50′. Long. 24° 1′. Height 978 ft. 15 Years, 1870–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	1	6	5	4	3	7	...
Feb.	1	3	2	6	4	3	3	6	...
March	2	4	2	5	5	4	3	6	...
April	2	5	3	5	5	3	3	4	...
May	3	5	2	4	4	4	4	5	...
June	2	5	2	4	5	3	3	6	...
July	3	5	2	3	4	3	4	7	...
Aug.	2	5	1	5	4	5	4	5	...
Sept.	2	4	1	5	5	5	3	5	...
Oct.	1	4	3	6	5	4	3	5	...
Nov.	2	2	1	6	5	5	3	6	...
Dec	1	2	1	5	5	6	4	7	...
Year	23	47	21	60	56	49	40	69	...

KRAKAU. Lat. 50° 4′. Long. 19° 57. Height 722 ft. 15 Years, 1870–84. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	8	1	0	0	3	11	2	5
Feb.	1	8	2	0	0	2	10	1	4
March	1	9	3	0	1	2	10	2	3
April	2	8	3	1	1	2	8	2	3
May	2	7	2	1	1	3	9	3	3
June	1	7	2	1	0	3	10	3	3
July	1	7	1	1	1	3	12	2	3
Aug.	1	7	2	1	0	3	10	2	5
Sept.	1	7	3	1	0	2	10	2	4
Oct.	1	10	2	1	0	3	8	2	4
Nov.	1	7	1	1	1	3	9	2	5
Dec	1	7	1	0	1	3	11	2	5
Year	14	92	23	8	6	32	118	25	47

PRAGUE. Lat. 50° 5′. Long. 14° 25′. Height 660 ft. 15 Years, 1870–84. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	2	4	6	8	4	2
Feb.	2	2	2	3	4	5	6	3	1
March	3	2	3	2	3	5	7	4	2
April	4	3	3	2	3	4	5	4	2
May	4	3	2	2	2	4	5	6	3
June	3	2	2	1	2	5	7	5	3
July	2	2	1	2	3	6	7	5	3
Aug.	3	2	2	1	3	6	7	4	3
Sept.	2	2	2	2	4	6	6	3	3
Oct.	2	2	3	2	4	6	7	2	3
Nov.	2	1	2	3	5	6	6	3	2
Dec	2	1	2	2	4	7	7	3	3
Year	30	24	26	24	41	66	78	46	30

OBIRGIPFEL. Lat. 46° 30′. Long. 14° 27′. Height 6706 ft. Hours, various. 10 Years, 1870–75, 1879–84.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	1	2	2	7	4	3	4
Feb.	4	3	2	2	2	6	3	3	3
March	6	2	1	2	2	7	3	5	3
April	4	2	1	3	4	8	3	3	2
May	4	3	2	2	3	7	3	4	3
June	3	2	1	2	2	9	3	4	4
July	3	2	1	2	3	9	3	3	5
Aug.	4	2	1	1	5	7	2	2	7
Sept.	3	2	2	2	4	6	3	4	4
Oct.	4	1	1	2	3	10	3	4	3
Nov.	4	2	1	2	3	9	3	4	2
Dec.	5	2	1	2	2	7	4	6	2
Year	49	26	15	24	35	92	37	45	42

VIENNA. Lat. 48° 14′. Long. 16° 22′. Height 664 ft. 15 Years, 1870–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	4	2	2	8	5	5
Feb.	2	1	1	6	2	1	7	5	3
March	4	2	2	4	2	1	8	6	2
April	5	2	2	3	2	2	6	6	2
May	4	2	1	3	2	1	8	6	4
June	3	2	1	3	2	2	9	6	2
July	3	2	1	2	1	1	10	7	4
Aug.	3	2	1	2	1	2	10	7	3
Sept.	2	1	1	4	2	2	8	6	4
Oct.	2	2	1	5	2	2	9	5	3
Nov.	2	1	1	4	3	2	9	4	4
Dec.	2	1	1	4	2	1	10	5	5
Year	34	19	15	44	23	19	102	68	41

LINZ. Lat. 48° 18′. Long. 14° 16′. Height 886 ft. 15 Years, 1870–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	1	2	6	3	1	3	8	2	5
Feb.	1	2	5	2	1	3	8	1	5
March	1	3	6	2	1	3	10	1	3
April	1	3	7	2	1	3	7	2	4
May	1	3	5	2	2	4	9	2	3
June	1	3	4	2	1	5	9	2	3
July	1	2	5	2	1	5	10	2	3
Aug.	1	2	5	2	1	3	10	2	4
Sept.	1	4	7	1	1	3	8	2	3
Oct.	1	3	7	2	1	3	8	2	4
Nov.	1	3	5	2	2	3	7	2	5
Dec.	1	2	5	2	1	3	9	2	6
Year	12	32	67	26	14	41	103	22	48

EGER. Lat. 50° 5′. Long. 12° 22′. Height 1493 ft. 15 Years, 1870–84. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	4	1	1	9	4	2	5
Feb.	2	3	5	1	1	6	4	2	4
March	2	4	5	1	2	6	5	2	4
April	4	4	4	1	1	4	4	3	5
May	4	4	3	1	1	4	5	3	6
June	3	3	2	1	1	5	6	3	6
July	3	2	2	1	1	7	6	2	7
Aug.	3	2	2	1	1	7	6	2	7
Sept.	2	2	2	1	2	6	6	2	7
Oct.	2	3	4	2	1	7	5	2	5
Nov.	2	2	4	1	2	8	5	1	5
Dec.	2	2	4	1	1	9	5	2	5
Year	31	34	41	13	15	78	61	26	66

MUNICH. Lat. 48° 8′. Long. 11° 34′. Height 1734 ft. 38 Years, 1843–80. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	7	2	1	3	10	1	3
Feb.	1	3	6	1	0	4	11	1	1
March	1	3	7	1	1	3	12	2	1
April	1	3	6	1	0	3	12	3	1
May	1	5	7	1	0	3	9	3	2
June	1	5	5	1	0	3	10	3	2
July	1	3	5	1	0	4	11	4	2
Aug.	1	3	5	1	1	4	11	3	2
Sept.	1	4	7	1	0	3	9	3	2
Oct.	1	3	8	2	1	3	8	2	3
Nov.	1	3	7	2	1	4	9	1	2
Dec.	1	3	7	2	1	1	4	10	2
Year	12	41	77	16	6	38	116	36	23

BAYREUTH. Lat. 49° 57′. Long. 11° 35′. Height 1132 ft. 18 Years, 1851–78. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	7	7	4	5	2	...
Feb.	3	1	2	6	4	4	6	2	...
March	5	1	2	5	4	4	7	3	...
April	6	2	3	4	4	4	4	3	...
May	6	2	3	4	3	4	6	3	...
June	6	2	2	3	3	4	6	4	...
July	5	2	2	3	4	4	7	4	...
Aug.	5	2	2	4	5	4	6	3	...
Sept.	3	3	3	5	5	4	5	2	...
Oct.	3	2	3	6	6	4	5	2	...
Nov.	4	2	2	6	6	4	4	2	...
Dec.	4	1	2	7	6	4	5	2	...
Year	53	21	28	60	57	48	66	32	...

MANNHEIM. Lat. 49° 29′ Long. 8° 27′. Height 368 ft. Years, ? Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	1	5	7	6	2	5	...
Feb.	2	3	1	3	5	6	3	5	...
March	2	2	1	4	5	6	4	7	...
April	3	3	1	4	5	5	3	6	...
May	4	2	1	4	3	4	4	9	...
June	3	2	1	3	5	6	4	6	...
July	3	2	1	3	5	6	4	7	...
Aug.	3	2	1	4	6	5	4	6	...
Sept.	5	2	1	5	5	4	2	6	...
Oct.	3	2	1	4	7	5	3	6	...
Nov.	3	2	1	6	7	4	2	5	...
Dec.	4	2	1	5	6	6	2	5	...
Year	38	26	12	50	66	63	37	73	...

AIX-LA-CHAPELLE. Lat. 50° 47′. Long. 6° 5′. Height 581 ft. 15 Years, 1858–72. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	3	1	15	4	3	...
Feb.	1	3	2	2	1	13	4	2	...
March	1	5	1	2	1	12	3	6	...
April	2	5	2	2	0	10	3	6	...
May	2	6	2	2	1	10	3	5	...
June	2	3	1	1	0	12	4	7	...
July	2	4	1	1	0	12	5	6	...
Aug.	1	3	2	1	1	15	3	5	...
Sept.	1	4	1	1	1	16	2	4	...
Oct.	1	4	2	3	1	14	3	3	...
Nov.	1	5	3	2	1	12	2	4	...
Dec.	1	3	2	2	1	16	3	3	...
Year	16	47	21	22	9	157	39	54	...

FRANKFORT-ON-MAIN. Lat. 50° 7′. Long. 8° 41′. Height 338 ft. 25 Years, 1857–81. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	4	2	3	10	3	1	3
Feb.	3	3	4	2	2	7	4	1	2
March	3	4	4	1	2	8	6	2	1
April	4	5	4	1	2	6	4	3	2
May	4	5	4	1	2	6	4	2	3
June	4	3	3	1	2	6	5	2	4
July	3	2	3	1	2	7	5	2	4
Aug.	3	4	2	1	3	7	5	1	5
Sept.	2	3	4	1	3	8	3	1	5
Oct.	2	3	4	2	3	8	3	1	5
Nov.	2	4	3	1	3	9	4	1	3
Dec.	2	4	3	2	3	11	3	1	2
Year	33	44	42	16	30	93	50	18	39

LEIPSIG. Lat. 51° 20′. Long. 12° 33′. Height 387 ft. Hours 6 : 2, 10. 38 Years, 1825–26, 1830–65.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	3	3	5	9	4	3	...
Feb.	1	3	3	3	4	9	2	3	...
March	2	4	3	3	3	7	4	5	...
April	2	4	3	3	2	6	5	5	...
May	3	5	4	3	2	5	4	5	...
June	2	3	2	3	2	7	5	6	...
July	2	3	2	3	2	7	6	6	...
Aug.	2	3	2	3	3	8	5	5	...
Sept.	2	3	3	4	3	7	4	4	...
Oct.	1	2	3	4	5	9	4	3	...
Nov.	1	3	3	4	5	9	3	2	...
Dec.	1	3	3	3	5	9	4	3	...
Year	20	39	34	39	41	92	50	50	...

BROCKEN. Lat. 51° 48′. Long. 10° 37′. Height 3747 ft. Hours 6 : 2, 10. 22 Years, 1836–50, 1853–59.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	3	4	3	7	7	4	...
Feb.	2	1	3	3	2	6	8	3	...
March	3	2	3	2	3	8	7	3	...
April	3	3	4	2	3	6	5	4	...
May	2	3	3	3	3	5	6	6	...
June	2	2	2	2	3	6	8	5	...
July	2	2	1	1	3	10	9	3	...
Aug.	2	2	2	2	4	9	6	4	...
Sept.	2	2	3	3	3	7	5	5	...
Oct.	1	2	2	3	3	9	7	4	...
Nov.	2	2	2	3	3	8	7	3	...
Dec.	2	2	2	3	3	8	7	4	...
Year	24	25	30	31	36	89	82	48	...

BERLIN. Lat. 52° 31′. Long. 13° 23′. Height 159 ft. 30 Years, 1848–77. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	5	3	5	7	6	2	...
Feb.	2	2	3	2	3	5	8	3	...
March	3	3	5	3	3	4	7	3	...
April	4	2	4	3	2	4	8	3	...
May	3	3	5	2	2	4	7	5	...
June	3	3	3	2	2	3	8	6	...
July	3	2	2	2	3	5	10	4	...
Aug.	2	2	3	2	3	5	9	5	...
Sept.	2	2	4	2	4	6	7	3	...
Oct.	1	3	4	3	5	6	7	2	...
Nov.	2	2	5	3	4	5	6	3	...
Dec.	2	1	5	3	4	6	7	3	...
Year	28	27	48	30	40	60	90	42	...

BRESLAU. Lat. 51° 7′. Long. 17° 2′. Height 483 ft. 51 Years, 1825–75. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	4	5	5	3	6	4	...
Feb.	2	2	3	4	4	3	6	4	...
March	2	2	4	4	4	3	6	6	...
April	3	3	4	4	3	2	6	5	...
May	4	3	4	4	2	2	6	6	...
June	3	3	3	3	2	2	7	7	...
July	3	2	3	3	2	3	8	7	...
Aug.	3	2	3	4	3	3	7	6	...
Sept.	3	3	3	4	3	3	6	5	...
Oct.	2	2	4	5	4	4	6	4	...
Nov.	2	2	4	5	5	3	6	3	...
Dec.	2	2	4	5	4	3	6	5	...
Year	31	28	43	50	41	34	76	62	...

POSEN. Lat. 52° 25′. Long. 16° 56′. Height 268 ft. 18 Years, 1848–65. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	5	5	4	6	5	2	...
Feb.	2	2	4	3	3	5	6	3	...
March	2	2	5	3	4	5	6	4	...
April	4	3	4	3	3	4	5	4	...
May	4	5	4	3	3	3	4	5	...
June	3	3	3	3	3	4	6	5	...
July	3	3	2	3	3	4	7	6	...
Aug.	3	2	3	3	3	5	7	5	...
Sept.	4	3	2	3	4	5	5	4	...
Oct.	2	3	5	4	5	6	4	2	...
Nov.	2	3	5	5	3	6	4	2	...
Dec.	2	2	4	4	5	7	5	2	...
Year	32	34	46	42	43	60	64	44	...

BROMBERG. Lat. 53° 8′. Long. 18° 0′. Height 154 ft. 32 Years, 1848–79. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	4	3	5	4	6	5	...
Feb.	2	2	4	2	3	4	6	5	...
March	3	3	6	3	4	3	4	5	...
April	3	3	5	3	3	3	4	6	...
May	4	3	5	2	2	3	5	7	...
June	4	3	4	2	3	3	4	7	...
July	3	3	3	2	2	4	7	7	...
Aug.	3	3	3	2	3	4	6	7	...
Sept.	2	2	3	2	3	5	6	7	...
Oct.	2	2	5	4	4	5	5	4	...
Nov.	1	2	3	4	4	6	6	4	...
Dec.	2	2	5	4	3	4	6	5	...
Year	31	30	50	33	39	48	65	69	...

KÖNIGSBERG. Lat. 54° 43′. Long. 20° 30′. Height 74 ft. 32 Years, 1848–79. Hours 6 : 2, 10, and 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	4	5	2	7	6	3	...
Feb.	1	3	3	5	1	6	6	3	...
March	2	5	4	4	2	5	6	3	...
April	3	4	4	4	1	4	6	4	...
May	4	4	3	4	1	4	6	5	...
June	3	3	3	4	1	4	8	4	...
July	3	2	3	3	1	4	9	6	...
Aug.	2	3	3	4	2	5	8	4	...
Sept.	2	3	3	4	1	7	7	3	...
Oct.	1	2	5	6	3	7	5	2	...
Nov.	1	3	4	6	2	7	5	2	...
Dec.	1	3	4	5	2	7	6	3	...
Year	24	38	43	54	19	67	78	42	...

GYDA-VIKEN. Lt. 72° 14′–72° 25′. Lg. 76° 14′–77° 12′. Height 0 ft. 1 Year, 1880–81. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	2	7	8	8	2	0	0	4
Feb.	4	4	1	5	3	4	1	4	2
March	1	2	0	5	8	8	3	2	2
April	5	3	2	3	3	7	2	4	1
May	2	4	1	4	3	8	5	2	2
June	4	6	2	4	2	2	2	4	4
July	4	7	3	3	3	2	2	5	2
Aug.	0	0	0	0	0	0	0	0	0
Sept.	0	0	0	0	0	0	0	0	0
Oct.	8	3	4	6	4	1	1	2	2
Nov.	4	2	1	3	10	4	1	2	3
Dec.	4	1	1	3	11	6	1	3	1
Year	36	34	22	44	55	44	18	28	23

KARA SEA. Lt. 70° 10′–71° 33′. Lg. 60° 5′–64° 58′. Height 0 ft. 1 Year, 1882–83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	5	3	2	5	3	1	3
Feb.	3	2	2	3	7	6	2	1	2
March	4	3	4	4	7	3	2	1	3
April	4	2	2	2	7	6	3	3	1
May	7	2	4	1	2	2	3	7	3
June	6	3	2	2	1	3	5	5	3
July	3	5	7	3	3	4	3	2	1
Aug.	3	5	5	3	3	3	3	3	3
Sept.	5	3	3	3	3	4	4	4	1
Oct.	5	4	1	1	1	4	6	6	3
Nov.	1	3	4	2	2	6	5	3	4
Dec.	2	1	1	1	3	10	7	3	3
Year	47	38	40	28	41	56	46	39	30

Month.	KOLA. Lat. 68° 53′ Long. 33° 1′. Height 33 ft. 9 Years, 1878–86. Hours 7 : 1, 9.									SHISHGUISKIJ. Lat. 65° 12′. Long. 36° 51′. Height 0 ft. 22 Years, 1843–65. Hours various.									L. MORSHOWEZ. Lat. 66° 46′. Long. 42° 30′. Height 0 ft. 13½ Years, 1843–65. Hours various.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	2	5	7	8	2	3	2	2	2	3	5	9	3	3	2	2	2	2	3	4	8	4	5	1
Feb.	1	0	1	3	7	7	5	1	3	1	3	4	3	5	6	2	1	3	2	2	1	2	4	8	5	2	2
March	2	2	1	1	5	6	7	2	5	2	4	3	2	6	8	2	2	2	3	3	2	2	4	7	5	3	2
April	3	2	2	2	5	4	4	3	5	3	5	3	2	4	7	2	2	2	4	4	3	3	3	5	3	3	2
May	4	3	4	2	3	3	2	2	8	3	6	4	1	4	6	2	3	2	6	5	3	3	2	5	2	3	2
June	5	4	4	2	3	2	2	2	6	3	7	6	1	3	5	2	2	1	8	4	3	3	2	4	2	3	1
July	7	4	4	2	3	3	1	1	6	1	8	7	1	4	5	1	2	2	8	4	3	3	2	5	2	2	2
Aug.	5	3	3	2	4	3	2	2	7	2	5	6	2	4	6	2	2	2	5	4	2	3	3	7	3	3	1
Sept.	3	2	2	2	7	5	3	1	5	3	3	4	2	5	8	2	2	1	4	3	1	4	3	7	3	4	1
Oct.	2	1	1	2	7	6	5	2	5	3	3	2	3	4	8	3	4	1	4	3	2	2	5	5	5	5	0
Nov.	1	1	1	2	7	8	5	1	4	2	2	2	3	4	9	4	3	1	2	2	2	2	4	7	6	4	1
Dec.	1	0	1	3	6	8	8	1	3	2	2	2	2	5	9	4	4	1	2	2	2	2	4	8	6	4	1
Year	36	23	25	25	62	62	52	20	60	27	50	45	25	53	86	29	30	20	50	38	26	32	40	76	46	41	16

Month.	KEM. Lat. 64° 57′. Long. 34° 39′. Height 41 ft. 15 Years, 1870–84. Hours 7 : 1, 9.									ORLOV. Lat. 67° 11′. Long. 41° 22′. Height 0 ft. 21 Years, 1843–65. Hours various.									MEZEN. Lat. 65° 30′. Long. 44° 16′. Height 52 ft. 4 Years, 1883–86. Hours 7 : 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	2	4	7	6	2	6	1	2	2	2	4	9	7	3	1	2	1	3	6	6	3	4	2	4
Feb.	2	1	1	1	2	5	8	2	6	1	2	1	2	5	8	5	3	1	1	1	1	5	7	6	3	1	3
March	3	2	1	2	3	5	6	3	6	2	3	1	3	3	9	6	3	1	2	1	1	4	8	6	4	2	3
April	2	3	2	2	3	4	4	3	7	4	3	1	2	2	7	5	5	1	3	2	3	3	5	4	3	4	3
May	4	6	4	2	2	3	2	2	6	5	3	1	2	3	5	4	6	2	5	6	4	3	2	2	3	5	1
June	3	5	4	2	2	3	3	2	6	5	2	1	2	3	4	3	8	2	5	5	3	3	2	1	3	6	2
July	3	5	4	2	3	3	3	2	6	4	1	1	3	4	4	2	10	2	6	3	3	4	3	2	1	5	4
Aug.	3	4	3	2	2	3	4	2	8	3	2	1	2	5	5	4	8	1	6	6	5	2	1	1	2	6	2
Sept.	3	2	1	2	4	4	5	3	6	3	2	1	2	3	6	5	7	1	4	3	3	3	3	3	3	4	4
Oct.	1	1	1	2	4	6	8	4	4	2	2	2	2	3	8	7	5	0	2	1	2	4	7	6	4	2	3
Nov.	1	1	2	2	4	5	7	3	5	1	2	1	2	3	10	7	4	0	1	1	2	6	8	6	3	1	2
Dec.	1	1	2	2	4	5	7	3	6	2	2	1	1	3	10	7	4	1	1	2	1	5	8	6	3	2	3
Year	28	32	26	23	37	53	63	31	72	33	26	14	25	41	85	62	66	13	38	32	31	48	60	46	36	40	34

Month.	ARCHANGEL. Lat. 64° 33′. Long. 40° 32′. Height 16 ft. 15 Years, 1870–84. Hours 7 : 1, 9.									PETROSAWODSK. Lat. 61° 47′. Long. 34° 23′. Height 233 ft. 18 Years, 1861–78. Hours various.									NIKOLSK. Lat 59° 32′. Long. 45° 27. Height 390 ft. 5 Years, 1882–86. Hours 7 : 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	4	5	6	5	3	2	3	1	1	2	3	1	6	6	6	5	5	2	1	6	5	5	2	3	2
Feb.	1	1	3	4	4	5	4	3	3	1	1	2	3	1	6	6	5	3	3	2	1	5	6	5	1	2	3
March	2	2	3	4	5	5	4	4	2	1	2	2	4	1	6	6	6	3	3	2	2	6	6	4	2	3	3
April	3	2	3	3	4	3	4	5	3	2	2	2	4	1	6	4	6	3	4	4	2	6	3	3	1	3	4
May	4	3	4	3	3	2	3	6	3	2	4	4	4	1	4	4	5	3	4	4	3	6	3	3	1	5	2
June	5	3	3	2	2	2	3	7	3	2	3	3	5	1	5	5	3	3	6	6	3	5	2	1	1	3	3
July	5	3	3	3	3	2	3	5	4	1	4	4	4	1	5	5	4	3	5	4	3	5	3	2	1	4	4
Aug.	5	3	3	3	3	3	3	5	3	2	3	3	3	2	4	6	5	3	4	5	3	6	3	1	1	4	4
Sept.	4	2	2	4	5	3	3	4	3	2	3	2	3	1	6	6	5	2	5	3	2	6	3	3	1	4	3
Oct.	2	2	2	4	6	5	5	3	2	1	2	1	2	2	7	8	6	2	5	2	1	6	5	4	1	4	3
Nov.	2	2	4	5	6	5	3	1	2	1	2	1	4	2	6	5	6	3	4	2	1	7	5	5	1	2	3
Dec.	1	2	4	6	6	4	2	2	4	1	1	1	3	2	6	7	6	4	2	1	1	9	7	5	1	2	3
Year	36	26	38	46	53	44	40	47	35	17	28	27	42	16	67	68	63	37	50	37	23	73	51	41	14	39	37

KARGOPOL. Lat. 61° 30′. Long. 38° 57′. Height 440 ft. 4 Years, 1883–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	2	2	1	2	8	4	3	3	6
Feb.	1	1	1	2	9	3	3	1	7
March	3	1	1	3	7	5	3	2	6
April	6	3	2	3	3	3	1	2	7
May	4	2	2	3	4	4	3	3	6
June	4	4	2	1	2	3	3	3	8
July	6	2	2	2	6	3	1	2	7
Aug.	6	5	4	1	2	2	2	3	6
Sept.	4	2	1	1	4	4	4	4	6
Oct.	2	2	1	1	10	4	3	3	5
Nov.	2	1	1	2	10	5	3	2	4
Dec.	2	2	0	3	10	5	2	2	5
Year	42	27	18	24	75	45	31	30	73

WJATKA. Lat. 58° 36′. Long. 49° 41′. Height 580 ft. 11 Years, 1874, 1877–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	2	6	4	4	2	11
Feb.	1	0	1	2	3	4	5	2	10
March	1	1	1	3	4	6	4	2	9
April	2	1	1	2	3	4	3	3	11
May	2	2	2	2	3	3	4	4	9
June	3	3	1	1	2	3	3	3	11
July	4	2	2	2	2	3	3	3	10
Aug.	4	2	2	2	2	3	4	3	9
Sept.	4	2	1	1	2	4	5	4	7
Oct.	2	1	1	1	5	6	6	3	6
Nov.	1	1	1	2	6	5	5	2	7
Dec.	1	1	1	3	7	4	4	2	8
Year	26	16	15	23	45	49	50	33	108

ST. PETERSBURG. Lat. 59° 56′. Long. 30° 16′. Height 19 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	5	5	5	4	5	2
Feb.	1	2	3	5	4	3	4	4	2
March	2	3	2	4	4	4	5	4	3
April	2	4	3	4	3	3	4	4	3
May	2	5	3	3	2	2	5	7	2
June	2	5	3	3	2	2	5	6	2
July	4	4	3	3	3	2	4	6	2
Aug.	3	3	2	4	4	3	4	5	3
Sept.	3	2	2	5	4	4	4	4	2
Oct.	2	2	2	5	6	5	4	4	1
Nov.	2	1	3	5	6	5	3	4	1
Dec.	2	2	3	5	5	4	3	5	2
Year	26	35	31	51	48	42	49	58	25

NIJNI-NOVGOROD. Lat. 56° 20′. Long. 44° 0′. Height 453 ft. 16 Years, 1838–53. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	2	4	4	5	4	3	4
Feb.	1	2	3	3	4	5	3	2	5
March	1	2	3	4	4	5	3	3	6
April	1	2	2	4	3	5	3	2	8
May	2	4	3	3	3	4	4	4	4
June	2	2	2	3	3	5	4	4	5
July	1	3	2	3	2	5	3	4	8
Aug.	3	3	3	3	1	3	4	4	7
Sept.	2	2	3	3	3	4	3	4	6
Oct.	1	3	2	3	4	6	3	4	5
Nov.	2	2	1	2	3	6	4	5	5
Dec.	2	2	2	3	5	5	3	4	5
Year	20	30	28	38	39	58	41	43	68

BALTISCHPORT. Lat. 59° 21′. Long. 24° 3′. Height 28 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	3	3	5	8	3	3	1
Feb.	2	3	4	3	4	5	3	3	1
March	3	5	3	2	4	6	3	3	2
April	2	6	3	2	3	5	4	3	2
May	3	6	2	1	2	5	5	5	2
June	2	6	2	1	2	4	6	5	2
July	3	5	2	1	2	4	5	6	3
Aug.	2	5	2	2	2	4	5	5	4
Sept.	2	2	2	4	4	6	4	4	2
Oct.	3	2	3	4	5	7	4	2	1
Nov.	2	3	4	4	5	6	3	2	1
Dec.	3	2	5	4	4	7	3	2	1
Year	30	47	35	31	42	67	48	43	22

HELSINGFORS. Lat. 60° 10′. Long. 24° 37′. Height 38 ft. 2 Years, 1882–83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	0	1	1	3	8	5	6	3
Feb.	5	1	1	1	2	5	3	6	4
March	7	2	2	1	1	9	4	4	1
April	3	3	6	4	3	6	2	2	1
May	3	2	4	2	2	10	5	2	1
June	1	3	6	3	1	10	4	1	1
July	3	1	5	3	3	9	4	2	1
Aug.	1	1	2	5	4	11	3	3	1
Sept.	3	2	4	3	5	10	1	2	0
Oct.	2	3	3	4	5	6	4	4	0
Nov.	4	4	2	3	6	6	2	2	1
Dec.	4	4	3	1	5	6	3	3	2
Year	40	26	39	31	40	96	40	37	16

DORPAT. Lat. 58° 23′. Long. 26° 43′. Height 223 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	4	5	6	6	3	2
Feb.	1	2	4	4	4	5	4	2	2
March	2	2	3	3	4	6	6	4	1
April	2	4	3	4	3	4	5	3	2
May	3	4	3	2	3	5	6	4	1
June	2	3	3	3	3	5	6	3	2
July	3	3	2	2	3	5	6	4	3
Aug.	3	3	2	3	3	6	6	3	2
Sept.	2	1	2	4	5	6	5	3	2
Oct.	1	2	3	4	7	6	5	2	1
Nov.	1	2	2	5	6	6	4	3	1
Dec.	2	2	3	4	5	6	5	3	1
Year	23	30	32	42	51	66	64	37	20

WINDAU. Lat. 57° 24′. Long. 21° 33′. Height 29 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	5	5	5	4	3	3
Feb.	2	2	4	4	4	3	3	3	3
March	4	2	3	3	4	5	3	3	4
April	4	3	4	2	2	5	3	3	4
May	5	2	2	2	2	6	4	5	3
June	5	2	2	2	2	6	4	4	3
July	4	1	2	2	2	7	6	5	2
Aug.	4	3	2	2	2	5	5	4	4
Sept.	3	2	2	4	4	5	4	3	3
Oct.	2	2	3	5	5	4	3	4	3
Nov.	2	2	3	5	6	4	3	3	2
Dec.	2	3	3	5	5	3	4	3	3
Year	40	25	32	41	43	58	46	43	37

WILNA. Lat. 54° 41′. Long. 25° 18′. Height 387 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	4	5	4	4	3	7
Feb.	2	1	2	4	5	3	3	2	6
March	2	1	2	3	6	4	4	3	6
April	3	2	3	3	4	2	3	3	7
May	3	2	2	2	4	3	5	4	6
June	2	2	2	2	3	2	4	4	9
July	3	1	1	2	3	4	5	4	8
Aug.	2	2	1	2	4	4	4	2	10
Sept.	2	1	1	3	5	3	4	2	9
Oct.	2	1	2	4	7	4	3	1	7
Nov.	1	2	2	3	6	5	3	2	6
Dec.	1	2	3	3	6	3	4	2	7
Year	25	18	22	35	58	41	46	32	88

WARSAW. Lat. 52° 13′. Long. 21° 2′. Height 392 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	3	6	4	4	6	3	2
Feb.	2	1	4	5	3	4	5	2	2
March	3	3	3	4	3	4	5	3	3
April	3	4	3	5	2	3	4	3	3
May	5	3	3	3	2	3	5	4	3
June	4	2	3	4	2	3	5	4	3
July	4	2	2	3	2	3	6	5	4
Aug.	4	3	2	3	2	4	6	4	3
Sept.	3	2	2	4	4	4	5	3	3
Oct.	2	2	3	7	4	4	5	2	2
Nov.	1	1	2	6	5	5	5	2	3
Dec.	2	2	3	5	4	5	5	3	2
Year	35	26	33	55	37	46	62	38	33

GORKI. Lat. 54° 17′. Long. 30° 59. Height 679 ft. 14 Years, 1871–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	4	2	4	4	4	6
Feb.	1	3	2	4	2	4	3	4	5
March	2	3	2	4	2	5	4	4	5
April	2	5	2	5	2	3	3	3	5
May	2	5	1	4	2	4	3	4	6
June	2	5	2	3	2	5	2	5	4
July	2	5	2	3	2	4	3	6	4
Aug.	2	5	1	3	2	4	4	6	4
Sept.	2	6	2	3	2	4	2	4	5
Oct.	2	3	3	5	2	4	3	3	6
Nov.	1	3	2	5	4	5	2	3	5
Dec.	2	2	2	5	4	5	3	4	4
Year	22	49	22	48	28	51	36	50	59

MOSCOW. Lat. 55° 50′. Long. 37° 33′. Height 509 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	3	7	5	6	3	3
Feb.	3	1	1	3	7	3	5	3	2
March	2	2	1	3	8	4	5	3	3
April	3	2	2	3	6	4	5	3	2
May	3	2	1	2	7	4	5	4	3
June	3	2	1	3	6	3	4	5	3
July	4	1	1	2	6	3	4	6	4
Aug.	3	1	1	2	7	4	5	4	4
Sept.	3	1	1	2	7	5	4	4	3
Oct.	3	1	1	2	10	5	5	2	2
Nov.	1	1	1	3	11	5	5	2	1
Dec.	2	1	1	3	9	5	5	3	2
Year	32	16	13	31	91	50	58	42	32

GULYNKI. Lat. 54° 14′. Long. 40° 0′. Height 354 ft. 14 Years, 1871–84 Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	1	3	8	4	6	2	2
Feb.	5	1	1	2	6	3	5	3	2
March	4	3	1	2	8	3	5	3	2
April	4	3	2	2	5	4	6	2	2
May	3	3	2	2	5	3	6	4	3
June	4	3	3	1	2	3	7	3	4
July	5	2	2	1	2	3	7	4	5
Aug.	4	2	2	1	3	3	7	4	5
Sept.	4	1	3	1	4	3	7	3	4
Oct.	3	2	1	2	7	4	7	2	3
Nov.	3	2	1	2	9	4	6	2	1
Dec.	4	1	1	4	8	3	6	2	2
Year	47	24	20	23	67	40	75	34	35

KIEV. Lat. 50° 27′ Long. 30° 30′ Height 600 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	2	4	3	3	5	6	3
Feb.	3	2	2	6	3	2	3	6	1
March	4	3	2	5	3	3	4	5	2
April	4	4	4	5	3	2	2	4	2
May	4	3	3	4	3	3	3	6	2
June	6	3	2	4	3	1	3	5	3
July	7	3	2	2	2	1	3	8	3
Aug.	5	2	2	3	2	2	4	7	4
Sept.	3	2	2	5	2	2	4	7	3
Oct.	3	3	3	6	3	3	3	4	3
Nov.	2	2	2	7	4	3	4	4	2
Dec.	3	2	3	5	3	3	5	5	2
Year	47	31	29	56	34	28	43	67	30

KISCHINEW. Lat. 46° 59′. Long. 28° 51′. Height 360 ft. 11 Years, 1870–80. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	5	3	4	1	3	2	10	0
Feb.	2	3	3	4	2	3	2	9	0
March	2	4	3	5	2	4	2	9	0
April	1	4	2	6	4	4	2	7	0
May	2	3	2	6	2	4	2	10	0
June	3	3	2	3	3	3	2	11	0
July	4	3	1	1	2	3	3	14	0
Aug.	3	4	1	3	3	4	2	11	0
Sept.	3	2	1	4	3	4	2	10	1
Oct.	2	3	3	6	4	4	2	7	0
Nov.	2	3	2	5	4	4	2	8	0
Dec.	2	3	3	4	3	5	2	9	0
Year	29	40	26	51	33	45	25	115	1

ODESSA. Lat. 46° 29′. Long. 30° 44′. Height 214 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	5	3	2	2	3	3	2	4
Feb.	5	5	3	2	3	2	2	2	4
March	5	5	4	2	4	3	2	2	4
April	3	3	4	4	5	3	1	2	5
May	5	3	3	4	6	3	2	2	3
June	6	3	3	2	4	3	2	3	4
July	8	2	2	2	4	3	2	4	4
Aug.	7	3	3	2	3	3	2	3	5
Sept.	6	3	2	3	3	2	2	2	7
Oct.	4	5	4	3	4	2	1	2	6
Nov.	5	4	4	2	4	3	1	2	5
Dec.	5	3	4	2	4	3	3	3	4
Year	66	44	39	30	46	33	23	29	55

LUGAN. Lat. 48° 35′. Long. 39° 20′. Height 170 ft. 17 Years, 1840–56. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	5	2	1	3	3	1	11
Feb.	1	2	4	2	2	3	4	1	9
March	2	3	5	1	3	3	5	2	7
April	2	3	5	2	2	3	5	1	7
May	1	3	6	2	2	3	4	2	8
June	2	2	3	1	1	3	6	2	10
July	2	2	3	1	2	2	5	3	11
Aug.	2	4	5	1	1	1	4	2	11
Sept.	2	2	5	2	1	2	3	2	11
Oct.	1	2	5	1	2	2	4	1	13
Nov.	1	3	6	1	2	2	3	1	11
Dec.	1	3	4	1	2	3	5	1	11
Year	18	33	56	17	21	30	51	19	120

TAGANROG. Lat. 47° 12′. Long. 38° 59′. Height 114 ft. 16 Years, 1817–32. Hours 7 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	11	2	3	1	3	2	3
Feb.	3	3	10	2	3	1	2	2	2
March	2	4	11	2	3	2	2	1	4
April	1	2	9	3	4	2	4	2	3
May	1	1	8	4	5	3	4	2	3
June	2	1	6	2	4	3	6	3	3
July	2	1	5	2	3	3	9	3	3
Aug.	2	2	8	3	3	3	4	2	4
Sept.	3	2	10	2	3	1	5	2	2
Oct.	2	2	12	2	3	1	4	1	4
Nov.	2	3	9	2	3	1	3	2	5
Dec.	2	2	12	3	3	1	2	1	5
Year	25	26	111	29	40	22	48	23	41

POLTAVA. Lat. 49° 33′. Long. 34° 38′. Height 547 ft. Hours (?). 21 Years, 1824–31, 1836–48.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	8	5	2	3	6	4	2	...
Feb.	1	5	5	3	2	6	5	1	...
March	1	4	7	3	2	7	5	2	...
April	3	5	7	2	1	5	4	3	...
May	1	4	5	3	2	6	7	3	...
June	1	3	1	4	1	6	9	5	...
July	1	3	2	2	2	8	8	5	...
Aug.	1	5	4	2	1	7	6	5	...
Sept.	1	7	5	3	1	5	4	4	...
Oct.	2	4	5	3	1	7	6	3	...
Nov.	1	7	6	2	1	4	6	3	...
Dec.	2	6	6	1	1	5	6	4	...
Year	16	61	58	30	18	72	70	40	...

SEBASTOPOL. Lat. 44° 37′. Long. 33° 31′. Height 199 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	8	4	2	3	3	1	2	5
Feb.	2	6	4	3	3	2	2	3	3
March	3	5	4	3	3	3	2	4	5
April	1	4	5	3	4	3	2	3	5
May	2	2	5	2	3	4	3	4	6
June	1	2	5	2	3	3	3	5	6
July	1	2	6	1	2	3	4	6	6
Aug.	2	4	8	1	1	2	3	5	5
Sept.	3	4	8	2	2	2	2	4	3
Oct.	2	5	7	3	3	2	2	3	4
Nov.	2	5	5	4	4	3	2	2	3
Dec.	1	7	4	4	4	3	2	2	4
Year	22	54	65	30	35	33	28	43	55

SYMPHEROPOL. Lat. 44° 56′. Long. 34° 5′. Height (?). 29 Years, 1825–53. Hours (?).

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	6	3	1	1	1	1	14
Feb.	2	2	6	3	1	1	2	1	10
March	1	3	6	3	1	1	3	4	9
April	2	2	5	3	2	1	4	5	6
May	0	1	5	3	1	2	7	3	9
June	0	1	4	3	1	3	7	2	9
July	0	0	5	4	1	3	6	2	10
Aug.	0	1	8	4	1	1	5	2	9
Sept.	1	2	7	3	0	1	3	2	11
Oct.	1	3	7	3	1	1	2	2	11
Nov.	1	3	5	3	1	1	2	2	12
Dec.	1	3	6	2	1	1	2	2	13
Year	10	24	70	37	12	17	44	28	123

NOWOROSSIJSK. Lat. 44° 43′. Long. 37° 46′. Height 12 ft. 13 Years, 1872–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	6	0	2	4	3	2	6	5
Feb.	2	8	0	3	3	2	2	4	4
March	2	7	1	4	3	2	2	4	6
April	1	6	2	5	3	1	2	3	7
May	1	4	3	5	3	2	2	3	8
June	2	4	3	4	3	2	2	3	7
July	2	4	2	3	2	2	3	5	8
Aug.	3	7	2	2	1	2	2	6	6
Sept.	2	9	1	2	1	1	4	5	5
Oct.	2	8	1	3	2	2	4	4	5
Nov.	2	6	1	3	3	1	4	5	5
Dec.	3	5	0	3	4	3	2	5	6
Year	25	74	16	39	32	23	31	53	72

POTI. Lat. 42° 8′. Long. 41° 36. Height 24 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	17	2	1	2	3	2	3
Feb.	0	1	15	1	1	3	3	2	2
March	1	1	11	1	2	6	4	2	3
April	1	1	8	1	2	7	4	3	3
May	1	1	6	1	2	7	4	4	5
June	0	1	4	2	2	7	5	3	6
July	0	0	3	2	3	9	6	3	5
Aug.	0	0	4	3	3	8	5	3	5
Sept.	0	1	8	2	2	5	5	2	5
Oct.	0	1	13	2	2	4	2	2	5
Nov.	0	1	16	2	1	2	2	1	5
Dec.	0	1	18	2	1	2	2	2	3
Year	3	10	123	21	22	62	45	29	50

ALEXANDROPOL. Lat. 40° 48′. Long. 43° 49′. Height 5010 ft. 8 Years, 1858–65. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	0	2	0	0	0	1	0	1	27
Feb.	1	2	0	0	0	1	0	0	24
March	1	3	1	0	0	1	0	0	25
April	1	7	0	0	0	4	0	1	17
May	0	7	1	0	0	4	1	1	17
June	1	11	0	0	0	2	0	1	15
July	1	17	1	0	0	1	0	0	11
Aug.	0	18	1	0	0	2	0	0	10
Sept.	0	12	0	0	0	2	0	1	15
Oct.	1	6	0	0	0	2	0	0	22
Nov.	0	3	0	0	0	1	0	0	26
Dec.	1	2	0	0	0	1	0	0	27
Year	7	90	4	0	0	22	1	5	236

TIFLIS. Lat. 41° 43′. Long. 44° 47′. Height 1343 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	0	3	1	0	1	6	16
Feb.	3	1	1	3	1	0	0	6	13
March	3	1	1	4	1	1	0	7	13
April	3	1	1	4	2	1	0	6	12
May	4	2	1	3	2	1	1	6	11
June	5	1	1	2	2	1	1	8	9
July	5	2	1	4	2	1	0	7	9
Aug.	4	1	1	4	2	1	0	6	12
Sept.	4	1	1	4	2	1	0	5	12
Oct.	2	1	1	4	2	0	0	4	17
Nov.	2	1	1	3	1	0	0	4	18
Dec.	4	1	0	1	1	0	0	6	18
Year	42	14	10	39	19	7	3	71	160

ASTRABAD. Lat. 36° 54′. Long. 53° 55′. Height —79 ft. 7 Years, 1873–79. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	5	2	1	4	4	1	9
Feb.	4	3	3	1	1	4	3	2	7
March	3	2	3	1	0	3	7	4	8
April	3	1	1	1	0	2	8	5	9
May	2	1	1	0	1	3	9	6	8
June	1	0	1	1	0	4	10	5	8
July	1	0	0	0	0	7	9	6	8
Aug.	0	0	0	0	1	8	8	7	7
Sept.	2	1	1	1	1	6	6	5	7
Oct.	2	2	3	1	1	5	3	4	10
Nov.	2	3	3	2	1	3	3	3	10
Dec.	2	4	4	2	1	4	3	1	10
Year	24	20	25	12	8	53	73	49	101

ASTRABAD. Lat. 36° 52′. Long. 54° 26′. Height —73 ft. 5 Years, 1852–56. Hours (?).

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	6	4	1	2	3	2	4
Feb.	5	4	5	1	1	2	5	1	4
March	6	3	3	2	0	3	6	5	3
April	5	2	3	1	0	2	9	4	4
May	4	1	1	0	1	3	10	6	5
June	4	1	1	0	1	4	10	4	5
July	3	0	1	0	1	4	12	6	4
Aug.	2	0	0	1	0	3	15	6	4
Sept.	3	1	1	1	1	5	10	5	3
Oct.	4	2	4	2	2	3	5	4	5
Nov.	3	5	7	2	1	3	2	2	5
Dec.	2	5	6	4	1	3	3	2	5
Year	45	29	38	18	10	37	90	47	51

LENKORAN. Lat. 38° 46′. Long. 48° 51′. Height —70 ft. 5 Years, 1882–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	1	1	1	1	6	9	4
Feb.	4	4	2	2	2	1	5	6	2
March	2	2	5	6	6	2	3	2	3
April	1	2	4	9	9	1	1	1	2
May	1	2	3	11	8	1	1	1	3
June	1	1	3	8	7	2	3	1	4
July	1	2	4	6	6	2	3	2	5
Aug.	1	3	4	7	3	2	3	2	6
Sept.	2	2	3	4	5	4	3	2	5
Oct.	2	4	2	3	4	2	6	3	5
Nov.	5	3	1	0	1	1	8	8	3
Dec.	5	3	1	1	1	2	8	6	4
Year	30	31	33	58	53	21	50	43	46

BAKU. Lat. 40° 22′. Long. 49° 50′. Height 7 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	3	0	2	2	7	1	4	3
Feb.	8	3	0	2	3	5	0	5	2
March	8	2	0	4	3	6	0	5	3
April	8	2	0	4	4	5	0	5	2
May	7	2	0	6	4	4	0	6	2
June	9	2	1	4	2	2	0	8	2
July	10	3	0	5	2	1	0	7	3
Aug.	8	2	1	6	3	2	0	7	2
Sept.	8	2	1	4	3	3	0	6	3
Oct.	8	3	0	4	4	4	0	5	3
Nov.	7	3	0	4	4	6	0	4	2
Dec.	8	3	0	2	3	7	0	5	3
Year	98	30	3	47	37	52	1	67	30

NOVO-PETROVSK. Lat. 44° 27′. Long. 50° 8′. Height 10 ft. 7 Years, 1852–58. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	6	5	8	3	1	2	3	...
Feb.	2	3	8	7	2	1	3	2	...
March	4	5	7	7	1	1	3	3	...
April	4	5	5	6	2	1	4	3	...
May	5	5	7	4	3	1	3	3	...
June	6	3	4	3	2	1	5	5	...
July	6	5	3	3	2	2	5	5	...
Aug.	5	5	4	5	3	1	4	4	...
Sept.	4	5	4	5	1	2	3	6	...
Oct.	3	3	5	7	5	1	3	4	...
Nov.	2	6	7	9	1	1	1	3	...
Dec.	3	4	5	8	2	1	3	5	...
Year	47	55	64	72	27	14	40	46	...

PETROVSK. Lat. 42° 59′. Long. 47° 31′. Height —33 ft. 5 Years, 1882–86. Hours 7 : 1, 9.

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	5	1	0	2	15	6
Feb.	1	1	1	9	2	0	1	9	4
March	1	2	2	12	2	0	1	7	4
April	1	1	3	9	1	0	1	9	5
May	1	1	3	11	1	0	1	8	5
June	1	2	3	8	1	0	3	7	5
July	1	3	4	10	1	0	2	5	5
Aug.	1	3	3	8	1	0	3	6	6
Sept.	1	2	2	10	1	0	3	6	5
Oct.	1	1	2	11	1	0	2	8	5
Nov.	1	1	1	10	1	0	1	10	5
Dec.	1	1	1	9	2	0	0	12	5
Year	12	18	26	112	15	0	20	102	60

NEW ALEXANDRIA. Lat. 51° 25′ N. Long. 21° 57′. Height 472 ft. 13 Years, 1872–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	1	3	2	10	2	6	1
Feb.	1	4	1	3	4	10	1	3	1
March	1	4	1	2	3	10	2	7	1
April	1	6	2	3	4	7	1	5	1
May	2	5	1	3	3	7	2	6	2
June	1	3	2	3	3	8	2	6	2
July	1	2	1	2	3	10	2	6	4
Aug.	1	2	1	3	3	10	2	5	4
Sept.	1	2	1	3	3	10	1	5	4
Oct.	1	4	1	3	4	9	1	5	3
Nov.	1	4	0	3	4	10	1	5	2
Dec.	1	4	1	3	4	10	2	5	1
Year	13	45	13	34	40	111	19	64	26

ASTRACHAN. Lat. 46° 21′. Long. 48° 2′. Height —68 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	5	6	4	2	3	4	2	3
Feb.	2	4	6	4	1	2	3	3	3
March	2	3	6	5	2	2	5	3	3
April	3	3	6	5	2	2	3	3	3
May	3	3	5	4	2	3	4	3	4
June	3	3	4	3	3	3	4	3	4
July	4	2	3	4	3	4	4	3	4
Aug.	3	4	5	5	2	2	3	3	4
Sept.	3	3	6	5	2	2	3	3	3
Oct.	3	4	7	5	1	2	3	3	3
Nov.	2	4	6	7	2	2	2	2	3
Dec.	2	4	7	5	2	2	3	3	3
Year	32	42	67	56	24	29	41	34	40

KAMYSCHIN. Lat. 50° 5′. Long. 45° 24′ Height 69 ft. 7 Years, 1880–86. Hours, 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	1	1	2	2	6	3	11
Feb.	1	4	2	2	1	1	4	2	11
March	1	5	2	1	1	3	3	2	13
April	2	6	2	1	2	1	2	2	12
May	2	3	2	1	2	2	3	2	14
June	2	3	1	1	1	1	4	3	14
July	2	4	3	1	1	2	4	3	11
Aug.	2	3	1	1	1	3	4	4	12
Sept.	2	3	1	1	1	2	3	4	13
Oct.	2	3	2	2	3	2	4	2	11
Nov.	1	1	2	2	3	2	3	3	13
Dec.	1	2	2	2	3	2	4	2	13
Year	19	41	21	15	21	23	44	32	148

SARATOW. Lat. 51° 38′. Long. 45° 27′. Height 614 ft. 7 Years, 1873–79. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	2	1	2	2	2	4	10
Feb.	2	3	3	2	3	3	1	4	7
March	4	2	2	3	2	2	3	3	10
April	4	4	2	2	2	2	2	5	7
May	3	3	2	3	1	2	3	5	9
June	5	4	1	1	1	2	2	7	7
July	3	3	1	1	2	3	3	7	8
Aug.	4	3	1	1	1	3	2	7	9
Sept.	4	2	1	2	2	2	1	7	9
Oct.	4	1	1	2	2	2	2	5	12
Nov.	2	2	1	2	3	4	2	4	10
Dec.	3	2	1	3	4	3	3	6	6
Year	42	33	18	23	25	30	26	64	104

ORENBURG. Lat. 51° 46′. Long. 55° 6′. Height 297 ft. 6 Years, 1870–75. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	6	1	3	2	6	4	...
Feb.	4	3	9	2	3	3	3	1	...
March	4	4	10	1	3	4	4	1	...
April	4	4	8	2	2	3	5	2	...
May	6	4	7	1	2	3	6	2	...
June	6	4	5	1	2	3	8	1	...
July	7	4	6	0	2	2	8	2	...
Aug.	8	4	5	1	2	3	5	3	...
Sept.	6	4	6	1	3	3	6	1	...
Oct.	4	3	4	1	4	6	7	2	...
Nov.	4	3	6	2	3	5	6	1	...
Dec.	4	4	7	2	4	4	5	1	...
Year	61	46	79	15	33	41	69	21	...

KASAN. Lat. 55° 47′. Long. 49° 8′. Height 249 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	3	8	3	4	2	7
Feb.	3	1	1	2	7	4	3	2	5
March	2	2	1	2	9	4	4	2	5
April	4	2	2	2	6	3	4	1	6
May	3	3	2	2	5	3	5	2	6
June	4	3	2	1	4	3	4	3	6
July	5	3	1	2	4	3	4	2	7
Aug.	4	2	1	2	4	3	4	3	8
Sept.	4	2	2	1	4	3	4	3	7
Oct.	2	2	1	2	7	4	6	3	4
Nov.	2	1	1	3	8	5	4	2	4
Dec.	2	1	1	3	9	3	4	2	6
Year	37	23	16	25	75	41	50	27	71

SLATOUST. Lat. 55° 10′. Long. 59° 41′. Height 1343 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	0	5	4	0	4	9	9
Feb.	0	0	0	4	3	1	5	8	7
March	0	0	0	5	4	1	4	7	10
April	0	0	0	5	3	1	5	6	10
May	1	0	1	6	3	1	4	7	8
June	1	0	1	5	3	1	4	7	8
July	1	0	2	5	2	1	4	7	9
Aug.	1	1	1	4	3	1	3	8	9
Sept.	1	1	1	4	2	1	4	9	7
Oct.	0	0	0	4	2	1	5	10	9
Nov.	0	0	0	3	3	1	6	8	9
Dec.	0	0	0	6	5	1	4	7	8
Year	5	2	6	56	37	11	52	93	103

TOBOLSK. Lat. 58° 12′. Long. 68° 16′. Height 355 ft. 10 Years, 1852–61. Hour 7:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	11	5	3	3	4	2
Feb.	1	1	2	10	5	2	2	3	2
March	1	1	1	8	6	4	2	4	4
April	1	1	2	7	7	5	2	4	1
May	3	2	3	4	3	3	4	7	2
June	4	2	3	4	2	5	3	6	1
July	4	3	2	5	4	3	2	6	2
Aug.	4	2	1	4	4	4	4	6	2
Sept.	1	2	1	4	4	6	5	5	2
Oct.	2	0	2	4	5	7	5	4	2
Nov.	1	1	1	5	5	7	5	3	2
Dec.	1	1	1	8	7	4	3	3	3
Year	24	17	20	74	57	53	40	55	25

OBDORSK. Lat. 66° 31′. Long. 66° 35′. Height 80 ft. 4 Years, 1883–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	1	3	5	2	2	0	11
Feb.	4	1	0	1	4	2	5	1	10
March	3	2	1	1	6	3	3	1	11
April	6	2	0	1	4	3	5	1	8
May	5	4	1	2	2	3	6	2	6
June	6	3	1	1	3	1	7	3	5
July	5	5	2	1	4	1	4	1	8
Aug.	8	5	2	1	2	1	4	1	7
Sept.	5	2	1	1	5	3	6	2	5
Oct.	4	1	1	1	7	3	6	1	7
Nov.	4	1	1	1	6	2	4	1	10
Dec.	4	1	0	1	8	2	1	1	13
Year	59	29	11	15	56	26	53	15	101

BERESOW. Lat. 63° 56′. Long. 65° 4′. Height 120 ft. 8 Years, 1879–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	2	0	2	11	4	2	1	3
Feb.	5	2	0	2	7	4	3	2	3
March	4	3	1	3	11	3	3	2	1
April	5	5	2	3	5	3	3	2	2
May	7	7	3	3	4	1	2	3	1
June	8	7	3	4	3	1	1	2	1
July	6	8	3	4	4	2	1	2	1
Aug.	7	6	3	3	3	2	2	4	1
Sept.	7	4	2	2	3	4	4	4	0
Oct.	5	2	1	2	7	5	5	3	1
Nov.	5	2	1	2	9	3	4	1	3
Dec.	3	2	0	2	12	5	4	1	2
Year	68	50	19	32	79	37	34	27	19

SURGUT. Lat. 61° 17′. Long. 73° 20′. Height 177 ft. 2⅓ Years, 1884–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	3	4	6	2	6	3	2
Feb.	2	4	3	3	4	2	6	1	3
March	2	3	5	4	6	2	4	3	2
April	4	2	3	1	3	3	7	3	4
May	6	3	4	2	4	1	6	4	1
June	6	4	5	2	1	2	4	5	1
July	8	6	4	3	2	1	1	2	4
Aug.	5	4	4	3	1	2	5	6	1
Sept.	3	4	7	5	2	3	3	2	1
Oct.	5	2	3	2	4	3	7	4	1
Nov.	3	3	4	4	3	4	5	2	2
Dec.	2	2	3	4	6	4	6	2	2
Year	48	40	48	37	42	29	60	37	24

BOGOSLOWSK. Lat. 59° 45′. Long. 60° 1′. Height 636 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	0	1	1	6	4	1	15
Feb.	2	1	0	1	1	5	5	1	12
March	1	1	1	1	2	7	4	2	12
April	2	2	1	1	1	6	4	2	11
May	3	3	2	1	1	5	5	2	9
June	3	5	1	2	1	4	3	3	8
July	4	4	2	1	1	3	4	3	9
Aug.	3	3	1	1	1	4	4	3	11
Sept.	2	2	1	1	1	5	4	3	11
Oct.	1	2	1	1	2	7	6	2	9
Nov.	1	2	1	1	1	7	5	1	11
Dec.	2	2	0	1	1	4	4	1	16
Year	26	28	11	13	14	63	52	24	134

IRBIT. Lat. 57° 41′. Long. 63° 2′. Height 223 ft. 11 Years, 1873–78, 80–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	1	3	8	5	2	10
Feb.	1	0	1	1	3	7	6	2	7
March	1	1	1	2	5	8	4	2	7
April	2	1	1	1	3	7	4	3	8
May	2	2	3	2	2	4	5	4	7
June	3	2	2	2	2	3	4	5	7
July	4	2	2	2	1	3	4	4	9
Aug.	3	1	2	2	2	3	4	4	10
Sept.	2	2	1	1	2	5	5	4	8
Oct.	2	1	1	1	3	8	6	4	5
Nov.	1	1	1	2	4	8	5	2	6
Dec.	2	1	1	2	2	6	5	2	10
Year	24	14	17	19	32	70	57	38	94

IRGIS. Lat. 48° 37′. Long. 61° 16′. Height 367 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	3	1	4	3	5	3	5
Feb.	5	3	2	1	2	2	6	3	4
March	5	3	4	1	2	3	5	3	5
April	4	4	6	1	3	2	4	3	3
May	4	3	5	2	3	2	5	3	4
June	5	3	3	1	2	2	6	4	4
July	5	2	3	1	2	2	7	5	4
Aug.	5	2	3	1	2	2	6	4	6
Sept.	4	1	3	1	4	2	6	4	5
Oct.	4	1	4	1	3	2	7	3	6
Nov.	4	2	3	1	3	2	6	2	7
Dec.	4	3	3	1	3	3	5	3	6
Year	54	29	42	13	33	27	68	40	59

TOMSK. Lat. 56° 30′. Long. 84° 58′. Height 254 ft. 8 Years, 1877–84. Hours 7 : 1, 9.

BARNAUL. Lat. 53° 20′. Long. 83° 47′. Height 459 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

MINUSSINSK. Lat. 53° 43′. Long. 91° 41′. Height ft. 1⅓ Year, 1885–86. Hours 7 : 1, 9.

Month.	TOMSK N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	BARNAUL N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	MINUSSINSK N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	5	9	7	1	1	4	0	2	0	1	2	13	2	1	10	2	10	0	0	2	7	8	2	...
Feb.	0	1	1	3	10	6	1	1	5	0	2	0	1	3	10	2	1	9	9	11	0	1	2	3	1	1	...
March	0	1	1	4	10	6	2	2	5	1	4	0	0	2	11	2	1	10	7	11	0	3	2	6	1	1	...
April	2	2	1	3	6	6	2	6	2	1	5	0	1	2	8	3	3	7	3	4	1	3	5	9	4	1	...
May	2	2	2	2	3	6	3	8	3	2	4	1	1	3	5	3	5	7	2	3	1	2	6	8	3	6	...
June	2	3	2	3	4	6	2	5	3	2	5	1	1	3	5	2	4	7	4	9	3	2	3	5	3	1	...
July	2	3	3	2	3	5	2	6	5	3	5	1	3	2	4	1	3	9	3	5	8	1	0	5	5	4	...
Aug.	2	4	3	3	3	6	2	4	4	2	4	1	3	2	4	1	4	10	1	7	10	1	2	6	3	1	...
Sept.	1	3	2	2	3	8	3	4	4	1	3	1	2	3	6	2	3	9	4	6	3	1	3	8	2	3	...
Oct.	1	1	1	3	6	9	3	5	2	1	2	0	1	3	12	2	3	7	2	6	1	1	3	11	3	4	...
Nov.	1	1	1	3	8	8	2	3	3	1	2	0	0	2	14	2	1	8	3	3	0	1	4	10	2	7	...
Dec.	1	2	2	3	8	6	1	1	7	1	3	0	1	2	11	2	1	10	1	2	2	2	4	12	4	4	...
Year	15	24	21	36	73	79	24	46	47	15	41	5	15	29	103	24	30	103	41	77	29	18	36	90	39	35	...

KARAKOL. Lat. 42° 30′. Long. 77° 26′. Height 5400 ft. 4 Years, 1882, 3, 5, 6. Hours 7 : 1, 9.

TASCHKENT. Lat. 41° 19′. Long. 69° 16′. Height 1516 ft. 13 Years, 1871–83. Hours 7 : 1, 9.

TEHERAN. Lat. 35° 41′. Long. 51° 25′. Height 3741 ft. 3 Years, 1884–86. Hours 7 : 1, 9.

Month.	KARAKOL N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	TASCHKENT N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	TEHERAN N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	2	2	5	8	1	1	0	12	1	4	2	1	1	1	1	2	18	4	4	3	2	2	3	3	1	9
Feb.	0	3	3	3	7	2	1	0	9	2	6	2	1	1	0	1	2	13	5	6	3	2	2	2	2	1	5
March	1	2	2	2	5	2	3	1	13	3	7	2	1	1	1	1	3	12	4	5	4	1	1	4	4	2	6
April	2	2	3	0	2	3	5	2	11	3	4	1	1	1	1	2	4	13	4	4	3	2	2	4	3	2	6
May	2	3	2	1	4	3	5	3	8	2	4	1	2	1	1	1	2	17	2	2	3	2	3	6	2	3	8
June	2	2	2	1	5	3	4	1	10	2	2	1	1	0	1	1	3	19	1	2	2	3	3	3	2	2	12
July	2	3	2	1	5	3	3	1	11	2	2	1	1	0	0	1	4	20	1	1	1	4	5	2	0	1	16
Aug.	1	2	2	1	4	4	3	2	12	2	1	0	1	1	1	1	4	20	1	2	2	4	4	1	1	0	16
Sept.	2	2	2	2	5	4	4	2	7	2	1	1	1	0	0	1	4	20	2	1	0	4	4	2	1	1	15
Oct.	1	3	2	2	6	3	6	2	6	2	3	1	1	1	1	1	3	18	1	2	1	3	4	4	1	1	14
Nov.	0	3	2	3	10	3	2	0	7	2	5	1	1	0	1	1	2	17	5	3	2	1	3	4	2	2	8
Dec.	0	3	2	5	10	1	0	0	10	2	6	1	1	1	1	1	2	16	5	3	3	2	3	3	2	2	8
Year	13	30	26	26	71	32	37	14	116	25	45	14	13	8	9	13	35	203	35	35	27	30	36	38	23	18	123

MERV. Lat. 61° 47′. Long. 37° 35′. Height 2851 ft. 1 Year, 1885–86. Hours 7 : 1, 9.

NUKUSS. Lat. 42° 27′. Long. 59° 37′. Height 216 ft. 9 Years, 1874–83. Hours 7 : 1, 9.

PEROWSK. Lat. 45° 51′. Long. 65° 27′. Height 509 ft. 7 Years. 1881–87. Hours 7 : 1, 9.

Month.	MERV N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	NUKUSS N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	PEROWSK N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	4	1	2	2	2	2	5	8	4	9	5	3	2	2	2	2	2	2	7	4	3	5	5	2	1	2
Feb.	3	5	7	2	1	1	1	4	4	3	8	4	2	1	2	2	2	4	2	9	5	2	3	3	2	1	1
March	4	4	4	5	2	1	2	4	5	5	7	5	3	2	2	2	2	3	4	9	4	3	2	3	2	2	2
April	2	4	5	6	1	1	2	2	7	4	8	5	2	1	2	3	3	2	3	7	7	2	2	2	2	2	3
May	5	2	3	6	0	0	2	9	4	5	8	4	2	1	1	3	4	3	4	7	5	2	2	3	4	2	2
June	...	...	...	...	...	...	...	...	...	7	7	2	1	1	1	2	5	4	3	7	4	2	1	1	5	4	3
July	7	8	2	1	0	0	0	6	7	10	8	1	1	0	1	1	5	4	4	6	2	2	1	1	4	7	4
Aug.	9	3	1	0	1	0	1	3	13	10	9	1	1	1	0	1	4	4	4	7	3	1	1	2	4	5	4
Sept.	6	4	4	1	1	1	0	1	12	6	9	3	1	1	1	1	4	4	3	8	1	1	1	3	6	3	4
Oct.	6	4	2	1	1	1	3	6	7	4	8	4	2	1	1	2	3	6	3	10	2	2	2	3	3	3	3
Nov.	...	...	...	...	...	...	...	...	...	3	9	5	2	1	1	2	1	6	3	8	4	2	3	3	3	1	3
Dec.	4	7	7	3	1	1	1	4	3	3	8	5	4	2	2	2	2	3	2	9	4	3	4	3	2	1	3
Year	...	...	...	...	...	...	...	...	...	64	98	44	24	14	16	23	37	45	37	94	45	25	27	32	39	32	34

KASALINSK. Lat. 45° 46′. Long. 62° 7′. Height 149 ft. 7 Years, 1870–73, 81–83. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	4	2	2	2	3	4	8
Feb.	3	3	3	1	1	4	3	3	7
March	4	5	3	2	1	2	4	3	7
April	3	5	4	2	1	2	3	3	7
May	2	6	2	1	1	2	4	6	7
June	3	4	1	1	0	2	5	7	7
July	2	3	1	1	0	3	6	6	9
Aug.	3	3	2	1	1	2	5	6	8
Sept.	4	3	2	1	1	2	3	5	9
Oct.	3	5	1	1	2	3	3	4	9
Nov.	3	3	3	2	1	3	3	4	8
Dec.	3	4	3	2	2	4	3	3	7
Year	37	46	29	17	13	31	45	54	93

ENISSEISK. Lat. 58° 27′. Long. 92° 6′. Height 275 ft. 13 Years, 1872–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	4	5	3	4	5	1	8
Feb.	1	0	5	3	3	5	4	1	6
March	1	1	3	3	5	5	5	2	6
April	2	1	2	2	4	5	6	5	3
May	3	1	2	2	3	4	6	7	3
June	4	1	2	2	3	4	4	7	3
July	2	2	3	3	4	4	5	5	3
Aug.	2	2	3	3	3	4	5	4	5
Sept.	2	1	4	3	3	5	5	3	4
Oct.	1	1	3	2	5	6	6	3	4
Nov.	0	1	4	3	5	6	5	2	4
Dec.	1	1	5	3	3	4	5	1	8
Year	19	13	40	34	44	56	61	41	57

TURUCHANSK. Lat. 65° 55′. Long. 87° 38′. Height 60 ft. 10 Years, 1877–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	4	8	10	2	1	1	2
Feb.	1	2	4	6	9	2	1	1	2
March	2	1	3	5	9	5	2	2	2
April	4	2	2	3	5	3	3	6	2
May	4	2	3	3	4	3	3	7	2
June	6	3	3	3	5	2	2	5	1
July	5	3	4	4	4	2	2	4	3
Aug.	4	2	4	5	5	3	2	3	3
Sept.	4	2	3	4	7	4	2	3	1
Oct.	2	1	2	5	8	4	3	3	3
Nov.	2	2	3	6	9	3	1	1	3
Dec.	1	1	3	6	12	3	1	2	2
Year	36	23	38	58	87	36	23	38	26

IRKUTSK. Lat. 52° 16′. Long. 104° 16′. Height 1537 ft. 13 Years, 1832–44. Hours 7 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	0	3	0	8	0	0	0	12
Feb.	8	0	1	0	8	0	0	0	11
March	10	0	0	0	12	0	0	1	8
April	13	0	0	1	8	0	0	2	6
May	12	0	0	1	10	0	0	3	5
June	10	0	0	2	10	0	0	4	4
July	9	0	0	1	11	1	0	3	6
Aug.	11	0	0	0	9	0	0	3	8
Sept.	13	0	0	0	8	0	0	1	8
Oct.	13	0	0	0	6	0	0	1	11
Nov.	13	0	1	0	6	0	0	1	9
Dec.	12	0	2	0	6	0	0	0	11
Year	132	0	7	5	102	1	0	19	99

IRKUTSK. Lat. 52° 16′. Long. 104° 16′. Height 1537 ft. 12 Years, 1873–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	3	1	0	1	3	18
Feb.	1	2	2	3	0	0	0	3	17
March	2	3	2	3	0	0	1	4	16
April	2	3	1	2	1	1	1	6	13
May	2	2	1	3	1	1	1	8	12
June	1	1	1	3	1	1	2	6	14
July	1	1	2	2	1	1	2	5	16
Aug.	1	1	1	2	1	1	1	5	18
Sept.	1	1	1	2	1	1	1	5	17
Oct.	1	1	2	2	0	1	1	5	18
Nov.	1	1	1	2	0	0	1	4	20
Dec.	1	1	1	2	0	0	1	3	22
Year	15	19	17	29	7	7	13	57	201

TROIZKOSSAWSK. Lat. 50° 22′. Long. 106° 27′. Height 2530 ft. 2 Years, 1885–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	0	0	4	2	2	6	15
Feb.	2	1	0	2	4	4	0	4	11
March	4	0	0	1	3	3	0	5	15
April	6	1	1	1	3	3	1	7	7
May	6	1	0	1	4	3	0	8	8
June	7	1	0	0	4	1	1	5	11
July	8	1	1	0	3	1	0	6	11
Aug.	6	1	1	1	2	2	1	5	12
Sept.	5	0	0	0	4	2	0	7	12
Oct.	5	1	0	0	3	2	0	6	14
Nov.	4	0	0	1	4	3	0	3	15
Dec.	2	0	1	1	4	3	1	3	16
Year	57	7	4	8	42	29	6	65	147

BANSCHTSCHIKOWO. Lat. 58° 3′. Long. 108° 35′. Height 984 ft. 3 Years, 1884–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	0	2	0	14	1	6	1	...
Feb.	5	1	2	2	13	1	3	1	...
March	6	1	3	1	11	2	6	1	...
April	7	1	2	1	8	1	7	3	...
May	8	0	3	1	13	0	5	1	...
June	7	1	2	1	12	0	6	1	...
July	17	0	1	0	6	0	5	2	...
Aug.	14	0	1	2	7	1	4	2	...
Sept.	8	0	1	1	11	1	7	1	...
Oct.	6	0	2	2	14	1	5	1	...
Nov.	6	0	4	0	16	0	3	1	...
Dec.	5	0	3	3	17	1	2	0	...
Year	96	4	26	14	142	9	59	15	...

OLEKMINSK. Lat. 60° 22′. Long. 120° 26′. Height 719 ft. 4 Years, 1883–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	1	1	0	1	6	1	21
Feb.	0	0	0	1	0	2	5	1	19
March	1	1	0	0	0	3	8	1	17
April	1	3	1	0	0	3	9	1	12
May	2	2	1	2	1	4	11	2	6
June	1	2	2	1	1	5	10	3	5
July	3	5	2	1	1	4	7	2	6
Aug.	2	4	2	1	0	4	6	2	10
Sept.	1	3	1	1	1	3	7	2	11
Oct.	1	2	1	0	0	3	11	2	11
Nov.	0	1	1	0	0	2	8	1	17
Dec.	0	0	2	1	0	0	6	1	21
Year	12	23	14	9	4	34	94	19	156

MARCHINSKOE. Lat. 62° 10′. Long. 129° 43′. Height 535 ft. 2 Years, 1885–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	0	1	2	2	1	6	9
Feb.	4	3	1	2	2	1	1	7	7
March	6	3	1	2	2	1	1	11	4
April	7	3	1	3	1	1	2	10	2
May	4	5	3	5	1	1	3	5	4
June	3	4	3	7	2	0	2	8	1
July	6	3	2	3	3	1	2	9	2
Aug.	4	4	2	2	2	2	2	10	3
Sept.	4	1	1	3	3	1	4	10	3
Oct.	4	2	2	2	2	3	3	11	2
Nov.	7	4	1	1	1	3	3	5	5
Dec.	10	6	0	1	2	2	1	6	3
Year	64	43	17	32	23	18	25	98	45

Month.	JAKUTSK. Lat. 61° 58′. Long. 129° 30′. Height 334 ft. 15 Years, 1829–44. Hour 7:								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	1	0	0	2	0	1	1	17
Feb.	6	1	1	0	2	0	1	1	16
March	5	1	1	0	3	0	2	2	17
April	6	1	1	1	3	1	3	2	12
May	5	1	3	1	3	1	4	2	11
June	3	1	4	2	3	1	3	1	12
July	3	1	3	2	5	1	3	1	12
Aug.	4	1	3	1	3	1	3	2	13
Sept.	4	1	2	1	3	1	3	2	13
Oct.	5	1	1	1	3	1	3	2	14
Nov.	8	1	1	0	1	0	1	1	17
Dec.	9	1	0	0	2	0	1	1	17
Year	67	12	20	9	33	7	28	18	171

Month.	BARGUSIN. Lat. 53° 57′. Long. 109° 38′. Height 1595 ft. 1 Year, 1885-86. Hours 7: 1, 9,								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	5	1	2	3	3	0	14
Feb.	0	1	1	0	0	1	4	2	19
March	...	...	...	...	...	...	...	...	...
April	0	0	1	0	1	11	11	1	5
May	0	1	0	1	0	12	7	2	8
June	1	0	1	0	0	16	3	1	8
July	1	2	5	0	1	9	7	0	6
Aug.	0	0	2	1	0	14	6	1	7
Sept.	0	2	3	1	0	7	6	1	10
Oct.	0	1	3	0	0	12	7	1	7
Nov.	0	2	1	1	0	6	3	1	16
Dec.	1	4	3	1	0	7	4	1	10
Year	...	...	...	...	...	...	...	...	...

Month.	WERCHOJANSK. Lat. 67° 34′. Long. 133° 51′. Height 460 ft. 4 Years, 1883–87. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	1	2	5	4	4	0	14
Feb.	1	1	2	2	5	4	2	0	11
March	1	2	4	2	3	2	1	1	15
April	2	3	3	2	5	3	2	0	10
May	6	5	3	2	4	3	1	2	5
June	6	5	5	1	5	2	2	1	3
July	5	5	2	2	3	3	1	3	7
Aug.	5	4	4	1	2	1	2	3	9
Sept.	5	3	1	1	1	3	2	2	12
Oct.	3	3	1	1	1	2	1	1	18
Nov.	2	3	1	1	1	4	2	1	15
Dec.	1	2	2	2	3	5	3	1	12
Year	37	37	29	19	38	36	23	15	131

Month.	SAGASTYR. Lat. 74° 48′. Long. 126° 45′. Height 16 ft. 2 Years, 1882–84. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	3	8	8	7	4	0	1
Feb.	0	1	4	6	6	4	4	1	2
March	0	2	7	8	5	2	4	1	2
April	1	2	7	4	2	4	6	3	1
May	1	3	7	5	3	3	5	3	1
June	1	3	9	6	2	2	5	2	0
July	5	6	11	6	0	0	0	3	0
Aug.	2	3	9	5	2	3	4	3	0
Sept.	1	1	2	6	4	6	7	3	0
Oct.	1	2	6	4	4	5	5	4	0
Nov.	2	2	1	2	5	6	7	4	1
Dec.	1	1	1	4	9	6	4	4	1
Year	15	26	67	64	50	48	55	31	9

Month.	SREDNE-KOLYMSK. Lat. 67° 10′. Long. 157° 10′. Height 98 ft. 2 Years, 1886–87. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	0	0	2	12	8	0	5
Feb.	0	0	0	0	1	13	11	0	3
March	7	1	1	1	1	5	1	3	11
April	7	5	1	2	0	3	2	2	8
May	9	9	2	0	1	1	2	2	5
June	7	7	3	1	1	1	2	4	4
July	7	5	2	1	1	0	5	5	5
Aug.	8	6	2	1	2	1	3	1	7
Sept.	6	6	3	0	1	1	3	1	9
Oct.	2	4	2	0	1	3	4	4	11
Nov.	2	0	1	0	2	7	6	3	9
Dec.	3	2	0	1	3	15	5	1	1
Year	59	48	17	7	16	62	52	26	78

Month.	KLJUTSCHEWSKOE. Lat. 56° 4′. Long. 160° 31′. Height 7 ft. 2 Years, 1885–87. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	0	0	1	6	2	19
Feb.	0	3	8	1	0	1	3	3	9
March	0	3	3	0	0	1	9	4	11
April	1	3	3	1	0	0	6	7	9
May	1	5	3	0	0	1	6	6	9
June	2	5	4	1	0	0	2	2	14
July	0	2	5	1	0	1	3	6	13
Aug.	0	7	7	0	0	1	3	3	10
Sept.	1	2	2	0	0	0	8	7	10
Oct.	2	1	0	0	0	0	8	13	7
Nov.	1	1	2	0	1	0	7	6	12
Dec.	3	0	2	0	0	1	7	4	14
Year	12	33	40	4	1	7	68	63	137

Month.	NERTSCHINSK. Lat. 51° 19′. Long. 119° 37′. Height 2080 ft. 15 Years, 1870–84. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	0	0	0	1	3	22
Feb.	1	3	2	0	0	1	1	3	17
March	1	3	2	1	1	1	1	6	15
April	2	2	1	2	1	3	2	8	9
May	3	4	1	2	1	2	2	8	8
June	2	4	2	2	2	2	1	4	11
July	2	4	2	2	1	3	1	3	13
Aug.	2	3	2	2	1	3	1	3	14
Sept.	2	2	1	1	1	2	2	5	14
Oct.	2	2	1	1	1	2	2	6	14
Nov.	1	2	1	1	1	2	2	4	16
Dec.	1	2	2	0	0	1	1	4	20
Year	20	33	19	14	10	22	17	57	173

Month.	BLAGOWESCHTSCHENSK. Lat. 50° 15′. Long. 127° 38. Height 361 ft. 10 Years, 1877–86. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	0	1	2	1	2	8	12
Feb.	5	0	0	1	2	1	1	7	11
March	5	1	1	1	3	2	1	8	9
April	5	2	2	1	4	2	2	6	6
May	6	2	2	3	4	3	2	4	5
June	3	2	2	4	5	3	2	4	5
July	3	2	2	3	7	3	1	4	6
Aug.	5	2	1	3	6	2	1	4	7
Sept.	4	1	1	3	4	2	2	4	9
Oct.	6	1	1	1	3	2	3	7	7
Nov.	5	1	1	1	2	1	2	7	10
Dec.	5	1	0	1	2	1	2	8	11
Year	56	16	13	23	44	23	21	71	98

Month.	CHABAROWKA. Lat. 48° 26′. Long. 135° 7′. Height 60 ft. 4 Years, 1878–81. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	0	0	1	8	2	2	16
Feb.	0	1	1	0	1	7	4	1	13
March	2	3	1	1	1	6	4	1	12
April	2	5	2	1	2	6	3	1	8
May	2	7	3	1	2	5	3	2	6
June	1	5	3	1	2	5	1	1	11
July	2	5	2	2	2	5	2	1	10
Aug.	1	5	2	2	3	6	3	1	8
Sept.	1	3	2	1	2	6	4	1	10
Oct.	1	2	2	2	2	9	7	1	5
Nov.	1	3	1	1	1	10	5	1	7
Dec.	1	3	1	0	1	8	5	1	11
Year	15	43	20	12	20	81	43	14	117

Month.	ALEXANDROWKA. Lat. 50° 50′. Long. 142° 7′. Height 53 ft. 6 Years, 1881–86. Hours, 7 : 1, 9.									DUE LIGHTHOUSE. Lat. 50° 50′. Long. 142° 7′. Height 330 ft. $3\frac{1}{2}$ Years, 1866–68, 74–75. Hours 7: 1, 9.									POST KORSSAKOWSKIJ. Lat. 46° 39′. Long. 142° 48′. Height 66 ft. 7 Years, 1877–83. Hours 7 : 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	9	1	0	4	3	1	1	4	8	9	2	5	4	3	1	1	3	3	9	6	1	1	1	1	2	7	3
Feb.	8	1	0	5	3	1	1	4	5	11	4	4	2	3	1	0	2	1	4	4	1	1	2	2	5	6	3
March	7	1	1	6	4	2	1	5	4	9	3	3	5	7	1	1	1	1	5	6	1	0	4	3	3	6	3
April	4	1	1	5	6	4	1	3	5	7	2	4	5	8	1	1	1	1	3	4	1	1	8	4	4	4	1
May	5	2	1	4	5	4	2	3	5	5	1	4	5	11	1	2	1	1	3	4	2	2	8	4	2	3	3
June	4	2	1	4	4	4	2	4	5	4	1	4	5	12	2	0	1	1	4	5	2	2	8	5	1	1	2
July	4	2	1	3	4	4	2	3	8	3	1	3	5	12	3	1	0	3	2	4	2	3	9	5	1	1	4
Aug.	3	1	1	5	7	4	2	3	5	5	1	3	9	8	1	1	0	3	1	3	2	2	7	6	1	2	7
Sept.	3	1	1	7	7	4	2	2	3	4	2	3	9	8	1	2	1	0	2	3	3	2	5	4	3	4	4
Oct.	4	1	1	5	7	3	2	5	3	5	3	3	4	9	2	2	2	1	3	3	2	2	4	4	4	4	5
Nov.	5	1	1	4	5	2	2	7	3	5	2	5	3	4	1	3	6	1	4	4	2	1	2	4	4	4	5
Dec.	8	1	0	4	4	1	2	6	5	10	4	2	3	2	1	2	6	1	8	4	1	1	1	2	3	6	5
Year	64	15	9	56	59	34	20	49	59	77	26	43	59	87	16	16	24	17	48	50	20	18	59	44	33	48	45

Month.	NIKOLAEWSK. Lat. 53° 8′. Long. 140° 45′. Height 60 ft. 13 Years, 1871–73, 75–81. Hours 7: 1, 9.									NIKOLAEWSK. Lat. 53° 8′. Long. 140° 45′. Height 65 ft. 6 Years, 1859–64. Hours 6 : 2, 10.									AJANSK. Lat. 56° 27′. Long. 138° 11′. Height 45 ft. Hours 7 : 2, 9. 2 Years, 1847–49.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	0	0	1	11	6	10	3	1	0	0	0	1	18	8	0	3	3	1	3	5	8	1	1	6
Feb.	1	0	1	0	0	1	10	5	10	3	1	1	0	0	1	12	10	0	3	5	2	1	2	3	2	1	9
March	1	2	3	1	0	1	7	4	12	5	4	4	1	0	1	9	7	0	2	11	1	1	3	3	0	1	9
April	2	3	4	3	0	1	5	2	10	2	4	9	3	0	1	7	4	0	2	9	1	1	5	4	0	1	7
May	1	3	7	8	0	0	3	1	8	2	5	11	5	0	0	6	2	0	3	10	1	0	3	5	1	0	8
June	1	1	6	11	0	1	1	1	8	1	5	13	6	1	0	2	2	0	2	10	1	0	2	8	2	0	5
July	1	1	6	9	0	1	2	2	9	2	3	14	4	0	1	4	3	0	1	10	3	0	1	7	1	1	7
Aug.	1	1	4	6	0	1	3	3	12	2	3	11	3	0	1	4	7	0	2	8	2	0	2	8	1	0	8
Sept.	1	1	3	3	0	1	5	3	13	3	4	6	3	0	0	6	8	0	0	13	2	0	2	5	1	0	7
Oct.	1	1	2	1	0	2	8	4	12	3	4	3	1	0	1	10	9	0	3	6	1	1	2	5	1	2	10
Nov.	0	1	1	1	0	1	11	5	10	2	2	1	1	0	1	11	12	0	3	6	1	2	3	4	3	2	6
Dec.	1	1	0	0	0	0	12	7	10	3	2	1	0	0	2	16	7	0	2	8	1	2	3	8	1	2	4
Year	12	16	38	43	0	11	78	43	124	31	38	74	27	1	10	105	79	0	26	99	17	11	33	68	14	11	86

Month.	DOUAI. Lat. 50° 50′. Long. 142° 10′. Height 8 ft. $3\frac{1}{4}$ Years, 1863–66. Hours 6 : 2, 10.									PETROPAULOVSK. Lat. 53° 0′. Long. 159° 39′. Height 50 ft. Hours $6\frac{1}{2}$, N. : $9\frac{1}{2}$. 5 Years, 1838, 1846, 48–50, old style.									PITLEKAJ. Lat. 66° 0′. Long. 175° 0′. Height 0 ft. Ten Months. Hourly.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	6	5	4	0	1	1	5	...	6	4	1	3	1	1	1	5	9	6	4	4	1	1	3	3	5	4
Feb.	6	4	6	7	1	1	1	2	...	5	5	2	3	1	1	1	4	6	7	0	0	2	4	2	2	8	3
March	6	2	4	10	2	2	2	3	...	2	3	4	4	2	2	2	3	9	9	2	1	2	4	2	2	7	2
April	5	2	4	10	3	1	2	3	...	2	4	2	3	2	2	2	5	8	10	2	0	1	2	2	2	9	2
May	5	2	3	9	4	3	2	3	...	1	2	2	6	4	1	3	4	8	8	6	4	1	3	1	2	6	0
June	6	2	2	6	7	3	2	2	...	1	3	2	5	6	1	2	3	7	9	2	0	1	4	6	1	5	2
July	7	2	2	8	7	2	2	2	...	1	3	1	6	4	1	2	4	9	3	5	5	2	5	5	2	3	1
Aug.	4	2	2	10	9	2	1	1	...	1	2	1	5	3	1	2	7	9	...	...	...	...	...	...	...	...	...
Sept.	3	2	2	9	8	1	2	3	...	1	2	2	5	2	0	6	7	5	...	...	...	...	...	...	...	...	...
Oct.	5	2	2	9	6	2	1	4	...	2	3	3	3	1	0	5	7	7	12	5	3	0	1	1	1	7	1
Nov.	5	2	2	7	2	3	2	7	...	3	5	2	2	0	1	3	7	7	18	4	0	0	0	0	0	8	0
Dec.	7	2	3	6	2	1	2	8	...	3	7	2	2	0	1	2	4	10	14	2	2	1	1	1	0	7	1
Year	68	30	37	95	51	22	20	43	...	28	43	24	47	26	12	31	60	94	...	...	...	...	...	...	...	...	...

OKHOTSK. Lat. 59° 20′. Long. 142° 40′. Height 12 ft. Hours various. 7⅝ Years, 1843–50, old style.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	23	4	1	0	0	0	0	3	0
Feb.	20	4	1	1	0	0	0	2	0
March	17	4	3	2	1	0	0	3	1
April	10	3	2	5	2	2	1	4	1
May	3	3	2	9	4	4	1	3	2
June	1	1	3	12	5	4	1	2	1
July	2	0	5	12	5	3	1	2	1
Aug.	5	2	5	8	4	3	0	3	1
Sept.	11	2	4	4	2	2	0	4	1
Oct.	19	3	2	1	0	0	1	5	0
Nov.	22	5	1	0	0	0	0	2	0
Dec.	25	4	0	0	0	0	0	2	0
Year	158	35	29	44	23	18	5	35	8

ANADYR RIVER MOUTH. Lat. 64° 55′. Long. 177° 19′. Height 20 ft. ¾ Year, 1866–67. Hours 6, N.: 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	4	9	1	1	2	8	3
Feb.	1	1	1	5	2	0	2	15	1
March	1	1	4	7	1	1	6	10	0
April	1	1	5	6	2	0	3	11	1
May	2	1	1	5	6	1	3	11	1
June	0	0	2	11	14	0	1	2	0
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	0	0	3	9	0	0	13	0	6
Nov.	5	1	6	1	0	0	9	8	0
Dec.	1	0	4	1	0	0	7	18	0
Year	...	...	...	...	...	...	...	...	...

NEMURO. Lat. 43° 20′. Long. 145° 34′. Height 43 ft. 2 Years, 1884–85. Hours 6: 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	1	1	2	2	9	12
Feb.	2	1	0	1	0	1	2	10	11
March	2	3	2	3	2	2	1	6	10
April	2	1	0	3	6	5	2	4	7
May	3	2	3	3	4	4	3	2	7
June	3	2	3	7	4	3	1	1	6
July	2	3	2	6	4	3	0	0	11
Aug.	4	2	1	4	4	6	1	0	9
Sept.	4	2	2	7	3	3	1	1	7
Oct.	4	1	2	4	4	3	3	4	6
Nov.	3	2	1	3	2	5	4	6	4
Dec.	3	1	1	1	2	4	6	8	5
Year	34	21	18	43	36	41	26	51	95

SAPPORO. Lat. 43° 4′. Long. 141° 23′. Height 60 ft. 3 Years, 1883–85. Hours 6: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	3	4	2	2	6	8
Feb.	3	0	1	3	2	1	1	7	10
March	2	1	1	3	4	1	1	9	9
April	3	1	1	8	4	1	1	6	5
May	2	1	2	9	4	1	1	6	5
June	2	1	3	12	3	0	0	5	4
July	2	1	1	12	2	1	0	5	7
Aug.	2	1	2	11	5	1	1	3	5
Sept.	2	1	2	10	4	1	1	3	6
Oct.	2	1	2	6	4	1	1	5	9
Nov.	3	1	1	3	5	3	3	5	6
Dec.	2	1	1	3	6	2	3	6	7
Year	28	11	19	83	47	15	15	66	81

HAKODATE. Lat. 41° 46′. Long. 140° 44′. Height 10 ft. 3 Years, 1883–85. Hours 6: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	2	1	0	1	1	9	8	1
Feb.	11	1	2	1	0	1	4	7	1
March	7	2	4	1	0	2	7	6	2
April	3	1	4	3	2	4	6	4	3
May	2	1	5	3	2	3	4	4	7
June	1	1	6	5	4	2	2	2	7
July	1	0	6	7	5	4	1	2	5
Aug.	2	1	6	6	3	2	3	2	6
Sept.	5	1	6	5	1	2	2	3	5
Oct.	7	1	3	3	1	2	6	5	3
Nov.	6	1	2	1	2	1	8	7	2
Dec.	6	1	1	0	1	1	11	8	2
Year	59	13	46	35	22	25	63	58	44

NIIGATA. Lat. 37° 55′. Long. 139° 3′. Height 21 ft. 10 Years, 1872–81. Hours 7: 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	1	0	5	4	5	9	1
Feb.	5	2	0	1	5	4	3	7	1
March	6	2	0	1	6	1	4	7	4
April	7	2	1	2	6	4	3	4	1
May	7	2	1	1	4	4	6	4	2
June	11	3	0	1	4	2	4	2	3
July	7	3	1	1	6	3	6	2	2
Aug.	10	2	0	1	6	4	3	4	1
Sept.	9	3	1	2	6	3	2	3	1
Oct.	7	3	1	1	6	4	4	4	1
Nov.	5	1	1	1	7	5	5	4	1
Dec.	5	2	1	1	6	5	5	6	0
Year	84	26	8	13	67	43	50	56	18

NIIGATA. Lat. 37° 55′. Long. 139° 3′. Height 32 ft. 3 Years, 1883–85. Hours 6: 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	6	1	4	8	5	2
Feb.	4	1	1	5	1	3	8	3	2
March	4	2	1	4	0	4	9	2	5
April	5	2	1	6	1	6	4	1	4
May	6	1	0	6	1	5	4	1	7
June	6	4	0	5	0	4	3	1	7
July	5	2	1	5	1	5	2	2	8
Aug.	6	2	1	8	1	3	3	1	6
Sept.	4	3	1	8	1	3	2	1	7
Oct.	4	3	1	8	2	3	4	2	4
Nov.	3	2	1	6	1	5	5	2	5
Dec.	2	0	0	7	3	5	9	4	1
Year	52	23	9	74	13	50	61	25	58

MIYAKO. Lat. 39° 38′. Long. 141° 59′. Height 100 ft. 3 Years, 1883–85. Hours 6: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	0	1	6	10	1	11
Feb.	2	1	1	0	0	4	6	1	13
March	2	2	3	0	1	7	9	1	6
April	2	2	1	1	3	6	8	0	7
May	2	2	2	0	3	6	6	0	10
June	2	3	2	0	3	2	3	1	14
July	3	3	2	0	1	3	3	1	15
Aug.	1	1	3	0	3	4	5	0	14
Sept.	1	1	2	0	3	4	5	0	14
Oct.	1	1	3	0	2	6	9	1	8
Nov.	2	1	2	0	1	9	11	1	3
Dec.	0	0	0	0	2	8	14	1	6
Year	19	17	22	1	23	65	89	8	121

SAKAI. Lat. 35° 33′. Long. 133° 13′. Height 7 ft. 3 Years, 1883–85. Hours 6: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	2	1	0	6	11	4	2
Feb.	3	4	4	0	1	4	8	3	1
March	3	6	2	1	1	4	8	5	1
April	4	8	3	1	1	2	4	4	3
May	4	8	3	0	1	3	4	4	4
June	5	9	3	1	0	2	3	3	4
July	4	8	3	1	1	2	3	4	5
Aug.	5	8	2	1	0	2	2	3	8
Sept.	3	8	3	1	1	1	2	4	7
Oct.	4	6	4	1	1	2	4	4	5
Nov.	3	3	2	2	1	6	8	3	2
Dec.	2	1	1	0	1	8	12	3	3
Year	42	72	32	10	9	42	69	44	45

TOKIO. Lat. 35° 4′. Long. 139° 46′. Height 69 ft. 3 Years, 1883–85. Hours 6 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	11	1	1	2	1	0	1	12	2
Feb.	10	2	1	1	1	0	1	9	3
March	8	1	1	2	3	1	1	8	6
April	5	3	3	4	6	2	1	4	2
May	5	3	3	4	7	2	1	5	1
June	3	4	3	5	7	2	1	2	3
July	2	3	3	5	12	3	0	1	2
Aug.	2	3	4	6	10	1	0	1	4
Sept.	5	5	3	4	5	1	1	4	2
Oct.	8	4	1	1	2	1	1	10	3
Nov.	10	3	1	2	2	1	1	8	2
Dec.	9	1	1	2	2	1	4	10	1
Year	78	33	25	38	58	15	13	74	31

KANAZAWA. Lat. 36° 33′. Long. 136° 40′. Height 95 ft. 3 Years, 1883-85. Hours 6 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	6	6	5	4	2	5	2
Feb.	2	2	5	5	3	2	3	3	3
March	2	2	5	4	3	2	3	4	6
April	2	3	7	4	2	3	2	3	4
May	1	3	5	3	3	3	4	3	6
June	1	3	6	2	1	3	3	4	7
July	1	1	4	3	2	3	3	4	10
Aug.	1	2	5	5	1	2	2	5	8
Sept.	1	2	5	5	1	2	3	1	10
Oct.	1	1	5	8	2	3	1	2	8
Nov.	1	2	5	6	3	4	2	3	4
Dec.	1	1	4	6	4	6	3	2	4
Year	14	23	62	57	30	37	31	39	72

KOCHI. Lat. 33° 33′. Long. 133° 34′. Height 20 ft. 3 Years, 1883–85. Hours 6 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	1	1	1	7	10	2
Feb.	4	3	2	1	1	0	6	10	1
March	4	3	2	2	2	0	6	8	4
April	3	2	3	4	3	1	7	6	1
May	2	2	3	4	4	0	7	8	1
June	1	2	4	5	5	1	5	6	1
July	1	2	4	6	6	1	4	5	2
Aug.	2	2	3	3	6	0	4	8	3
Sept.	1	2	3	4	5	0	4	6	5
Oct.	3	2	1	1	4	1	5	8	6
Nov.	4	2	2	1	2	1	6	11	1
Dec.	4	3	1	2	2	1	6	10	2
Year	33	28	30	34	41	7	67	96	29

NAGASAKI. Lat. 32° 44′. Long. 129° 52′. Height 189 ft. 3 Years, 1883–85. Hours 6 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	3	1	2	0	1	2	5	8
Feb.	10	4	1	1	0	1	0	3	8
March	7	4	1	2	0	3	2	3	9
April	6	3	3	2	2	5	2	1	6
May	3	3	2	2	1	8	2	1	9
June	2	3	2	2	2	11	1	0	7
July	2	1	2	4	5	9	1	0	7
Aug.	1	5	2	2	2	8	1	0	10
Sept.	4	4	2	1	1	5	1	1	11
Oct.	5	8	2	1	1	3	1	1	9
Nov.	8	5	2	1	1	1	1	4	7
Dec.	10	3	1	1	0	1	2	5	8
Year	67	46	21	21	15	56	16	24	99

WLADIWOSTOK. Lat. 43° 4′. Long. 131° 54′. Height 86 ft. 8 Years, 1877–79, 81–85. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	1	0	1	0	1	0	11	7
Feb.	9	2	1	2	0	0	0	7	7
March	7	3	1	4	1	1	1	6	7
April	4	2	1	9	2	2	1	4	5
May	3	1	2	12	2	2	1	3	5
June	1	1	2	15	3	1	1	1	5
July	1	1	2	16	2	1	1	1	6
Aug.	4	2	1	11	2	1	1	2	7
Sept.	7	1	2	7	2	1	1	3	6
Oct.	7	2	2	5	1	1	1	6	6
Nov.	9	3	1	3	0	1	1	8	4
Dec.	14	2	1	1	0	0	1	6	6
Year	76	21	16	86	15	12	10	58	71

KAMEN-RYBOLOW. Lat. 44° 46′. Long. 132° 24. Height (?) ft. 2 Years, 1885–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	0	0	0	0	1	5	22
Feb.	3	0	0	0	1	2	2	10	10
March	4	1	0	0	5	2	0	5	14
April	1	0	1	0	9	5	3	3	8
May	2	1	1	1	7	3	2	2	12
June	1	1	0	4	8	4	1	0	11
July	1	0	0	3	8	6	2	5	6
Aug.	1	1	0	0	3	4	3	2	17
Sept.	5	1	1	1	4	1	1	1	16
Oct.	3	2	0	1	3	6	0	3	13
Nov.	3	1	0	0	1	2	2	3	18
Dec.	3	2	0	1	0	1	1	2	21
Year	29	11	3	11	49	36	18	41	168

NOWOKIEWSKOE. Lat. 42° 48′ Long. 130° 44′. Height (?) ft. 1 Year, 1886. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	1	4	2	1	0	20	1
Feb.	2	1	1	1	1	0	0	19	3
March	2	1	3	4	2	0	1	15	3
April	2	1	2	7	4	0	1	5	8
May	0	0	3	9	6	0	1	4	8
June	0	1	4	11	3	0	1	4	6
July	1	0	2	12	5	2	0	2	7
Aug.	1	1	3	11	2	1	2	3	7
Sept.	4	2	1	7	2	2	3	6	3
Oct.	2	1	3	6	3	1	2	8	5
Nov.	1	1	1	3	0	1	1	16	6
Dec.	2	1	1	1	0	0	1	20	5
Year	19	10	25	76	30	8	13	122	62

FUSAN. Lat. 35° 6′. Long. 129° 2′. Height 26 ft. 1½ Years, 1884–85. Hours 6 : 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	12	0	1	0	1	1	11	2	3
Feb.	13	0	0	1	1	2	7	2	2
March	9	0	1	1	3	2	8	3	4
April	7	1	1	0	4	2	6	2	7
May	8	0	0	1	5	3	7	1	6
June	8	1	0	0	6	4	5	0	6
July	6	1	0	1	4	8	6	1	4
Aug.	7	1	1	1	5	6	3	2	5
Sept.	10	1	0	1	3	2	3	2	8
Oct.	10	0	1	1	3	2	4	1	9
Nov.	7	1	1	1	2	1	9	2	6
Dec.	9	0	0	0	1	1	14	1	5
Year	106	6	6	8	38	34	83	19	65

NEWCHWANG. Lat. 40° 57′. Long. 121° 27′. Height (?) ft. 1 Year, 1861–62. Hours A.M. : P.M.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	8	1	0	1	1	0	1	0
Feb.	6	4	0	3	4	4	2	5	0
March	5	6	1	3	3	4	4	5	0
April	4	5	2	1	4	9	3	2	0
May	3	3	1	2	5	9	2	5	1
June	1	3	1	3	4	8	6	1	3
July	2	1	3	6	11	5	1	0	2
Aug.	4	9	1	11	4	2	0	0	0
Sept.	4	5	1	2	5	8	2	3	0
Oct.	6	6	1	2	4	4	4	2	2
Nov.	7	6	2	4	6	2	0	1	2
Dec.	7	8	4	8	2	1	0	1	0
Year	58	64	18	45	53	57	24	26	10

PEKIN. Lat. 39° 57′. Long. 116° 28′. Height 123 ft. 34 Years, 1841–74. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	0	1	2	2	1	8	11
Feb.	3	2	1	2	3	3	1	6	7
March	3	2	1	2	5	3	1	6	8
April	2	2	1	3	5	4	1	5	7
May	3	2	1	3	7	3	1	5	6
June	3	3	2	4	5	3	0	3	7
July	3	3	1	3	5	2	0	3	11
Aug.	4	3	1	2	4	2	0	3	12
Sept.	4	2	1	2	4	3	1	5	8
Oct.	3	2	1	2	3	4	1	6	9
Nov.	4	2	0	2	2	3	1	7	9
Dec.	4	2	0	1	2	2	1	8	11
Year	40	27	10	27	47	34	9	65	106

PEKIN. Lat. 39° 57′. Long. 116° 28′. Height 123 ft. 15 Years, 1870–84. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	0	1	1	1	...	7	17
Feb.	2	2	0	1	1	2	...	5	15
March	2	1	0	2	2	3	...	5	16
April	1	1	0	2	3	3	...	5	15
May	1	2	0	3	3	4	...	4	14
June	1	1	1	3	3	3	...	3	15
July	1	2	0	1	2	2	...	2	21
Aug.	1	1	0	1	2	2	...	3	21
Sept.	1	2	0	1	2	2	...	3	19
Oct.	1	1	0	1	3	3	...	5	17
Nov.	1	1	0	1	0	2	...	7	18
Dec.	2	2	0	1	0	1	...	8	17
Year	16	18	1	18	22	28	...	57	205

TSCHÖN-KIANG. Lat. 32° 21′. Long. 119° 4′. Height (?) ft. 2 Years, 1879, 81. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	11	...	7	...	3	...	9	1
Feb.	...	12	...	8	...	2	...	6	0
March	...	12	...	11	...	4	...	3	1
April	...	8	...	13	...	4	...	5	0
May	...	6	...	14	...	6	...	4	1
June	...	4	...	14	...	7	...	4	1
July	...	8	...	10	...	7	...	4	2
Aug.	...	11	...	10	...	5	...	4	1
Sept.	...	13	...	11	...	3	...	3	0
Oct.	...	12	...	13	...	1	...	3	2
Nov.	...	10	...	9	...	2	...	8	1
Dec.	...	11	...	5	...	4	...	11	0
Year	...	118	...	125	...	48	...	64	10

TAKU. Lat. 38° 59′. Long. 117° 40′. Height 18 ft. 3 Years, 1873–75. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	5	...	3	...	6	...	11	6
Feb.	...	6	...	4	...	4	...	9	5
March	...	5	...	13	...	4	...	7	2
April	...	6	...	11	...	6	...	4	3
May	...	6	...	12	...	5	...	4	4
June	...	7	...	15	...	3	...	2	3
July	...	4	...	17	...	5	...	2	3
Aug.	...	7	...	11	...	4	...	3	6
Sept.	...	12	...	8	...	4	...	4	2
Oct.	...	6	...	8	...	9	...	7	1
Nov.	...	8	...	5	...	8	...	8	1
Dec.	...	7	...	3	...	5	...	12	4
Year	...	79	...	110	...	63	...	73	40

SUNG-SHU-CHWANG. Lat. 36° 7′. Long. 103° 56′. Height 4987 ft. 7 Months, 1882–83. Hour: 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	8	4	1	0	0	15	1	0
Feb.	0	2	2	4	2	0	0	3	15
March	0	1	0	0	0	1	3	2	24
April	1	4	1	5	2	1	1	2	13
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	..
Sept.	...	...	...	...	...	...	...	...	...
Oct.	4	2	0	2	0	1	5	6	11
Nov.	3	7	5	2	0	0	3	1	9
Dec.	3	4	1	3	0	3	4	6	7
Year	...	...	...	...	...	...	...	...	...

HANKOW. Lat. 30° 32′. Long. 114° 19′. Height 260 ft. 4 Years, 1877–81. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	4	9	2	3	0	1	3	1
Feb.	8	4	6	2	4	1	1	1	1
March	6	3	8	3	5	1	3	1	1
April	6	5	5	3	6	1	2	1	1
May	4	4	6	4	7	1	2	2	1
June	2	2	9	3	9	2	1	1	1
July	2	4	6	3	6	4	3	2	1
Aug.	4	3	8	3	4	4	3	1	1
Sept.	5	7	8	3	2	1	1	2	1
Oct.	10	5	7	2	2	0	1	2	2
Nov.	8	5	8	2	2	1	2	1	1
Dec.	7	8	7	3	2	1	1	2	0
Year	70	54	87	33	52	17	21	19	12

SWATOW. Lat. 23° 22′. Long. 116° 41′. Height (?) ft. 3 Years, 1878–80. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	19	...	5	...	0	...	4	3
Feb.	...	19	...	4	...	0	...	4	1
March	...	14	...	9	...	1	...	2	5
April	...	16	...	7	...	1	..	1	5
May	...	11	...	9	...	7	...	1	3
June	...	9	...	6	...	13	...	0	2
July	...	2	...	11	...	11	...	1	6
Aug.	...	2	...	10	...	12	...	3	4
Sept.	...	14	...	9	...	3	...	1	3
Oct.	...	25	...	3	...	0	...	1	2
Nov.	...	20	...	3	...	0	...	3	4
Dec.	...	20	...	5	...	0	...	3	3
Year	...	171	...	81	...	48	...	24	41

AMOY. Lat. 24° 29′. Long. 118° 29′. Height (?) ft. 2 Years, 1880–81. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	13	3	0	1	2	0	1	11
Feb.	0	10	7	3	1	1	0	0	6
March	0	13	3	1	5	0	0	0	9
April	1	7	2	8	1	3	1	0	7
May	0	6	4	5	6	1	1	1	7
June	0	2	2	5	2	8	1	0	10
July	0	3	1	7	4	6	1	0	9
Aug.	1	4	1	5	4	4	1	0	11
Sept.	0	11	1	3	2	1	0	1	11
Oct.	0	21	2	1	1	0	0	0	6
Nov.	0	16	0	1	1	0	0	0	12
Dec.	0	18	4	0	0	1	1	0	7
Year	2	124	30	39	28	27	6	3	106

FOOCHOW. Lat. 26° 8′. Long. 119° 38′. Height 34 ft. 1½ Years, 1886–87. Hour: 8.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	26	1	1	0	0	0	1	0
Feb.	0	21	3	1	0	0	2	0	1
March	...	...	...	...	...	...	...	...	...
April	0	13	3	11	0	1	0	0	2
May	1	21	2	3	0	1	1	1	1
June	0	8	2	6	2	7	1	0	4
July	0	4	0	4	0	19	0	1	3
Aug.	1	7	0	2	0	16	0	4	1
Sept.	0	28	0	0	0	0	0	0	2
Oct.	0	30	0	0	0	0	1	0	0
Nov.	0	25	3	1	0	1	0	0	0
Dec.	0	27	1	1	0	1	0	1	0
Year	...	...	...	...	...	...	...	...	...

Month.	NINGPO. Lat. 29° 53′. Long. 121° 34′. Height (?) ft. 1 Year, 1881. Hours (?)									HONG KONG. Lat. 22° 16′. Long. 114° 9′. Height 43 ft. 15 Years, 1870–84. Hours 9 : 3.									MACAO. Lat. 22° 11′. Long. 113° 32′. Height 26 ft. 1 Year, 1882. Hours 10 : 4, 10.								
	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	5	...	2	...	7	...	11	6	2	9	12	0	0	0	2	2	4	7	4	8	6	1	0	0	4	1
Feb.	...	5	...	6	...	6	...	8	3	2	7	13	1	0	0	1	1	3	11	3	4	3	1	0	0	5	1
March	...	5	...	4	...	6	...	13	3	1	7	14	2	0	1	1	1	4	6	3	7	9	2	1	0	2	1
April	...	5	...	9	...	9	...	3	4	0	6	13	3	0	2	1	1	4	3	2	6	10	5	2	0	1	1
May	...	5	...	8	...	9	...	6	3	0	5	12	4	2	4	2	0	2	1	1	7	7	6	6	2	1	0
June	...	3	...	9	...	12	...	3	3	0	2	7	4	3	7	3	0	4	0	1	5	8	10	4	2	0	0
July	...	1	...	4	...	20	...	2	4	0	1	7	5	3	6	4	1	4	1	2	7	5	6	8	1	1	0
Aug.	...	3	...	10	...	11	...	3	4	0	2	6	3	3	6	4	1	6	1	1	7	4	3	10	3	2	0
Sept.	...	6	...	6	...	5	...	6	7	1	5	11	2	1	3	2	1	4	2	4	11	5	2	3	1	2	0
Oct.	...	6	...	4	...	3	...	10	8	2	9	14	1	0	0	1	1	3	2	5	12	9	2	0	1	0	0
Nov.	...	4	...	3	...	4	...	13	6	3	8	13	1	0	0	1	1	3	14	9	4	1	0	0	0	2	0
Dec.	...	6	...	1	...	3	...	17	4	3	8	12	1	0	0	2	1	4	13	6	5	2	1	0	0	3	1
Year	...	54	...	66	...	95	...	95	55	14	69	134	27	12	29	24	11	45	61	41	83	69	39	34	10	23	5

Month.	KELUNG. Lat. 25° 20′. Long. 121° 46′. Height 49 ft. 2 Years, 1873–75. Hours 7 : 1, 9.									TAMSUI. Lat. 25° 12′. Long. 121° 24′. Height (?) ft. 1 Year, 1876. Hours (?)									SOUTH CAPE. Lat. 21° 55′. Long. 120° 51′. Height 121 ft. 1½ Years, 1886–87. Hour : 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	21	3	0	0	1	1	1	2	...	24	...	3	...	0	...	1	3	2	25	2	0	0	0	0	0	2
Feb.	3	13	2	1	0	3	1	2	3	...	19	...	6	...	0	...	1	2	1	24	1	0	0	0	0	0	2
March	4	14	1	2	0	3	0	2	5	...	17	...	9	...	1	...	1	3	...	...	...	...	...	...	...	...	...
April	2	11	3	3	1	4	0	0	6	...	16	...	5	...	0	...	4	5	1	20	0	0	0	1	2	2	4
May	1	7	3	2	0	7	1	0	10	...	18	...	9	...	1	...	1	2	4	18	2	1	0	0	5	0	1
June	2	5	1	1	1	10	0	1	9	...	5	...	8	...	12	...	2	3	0	11	3	1	3	1	2	3	1
July	1	5	1	2	2	13	0	1	6	...	8	...	17	...	3	...	2	1	3	10	1	4	3	1	3	2	4
Aug.	1	5	1	2	1	11	1	0	9	...	4	...	21	...	4	...	2	0	1	5	3	1	5	3	9	2	2
Sept.	2	9	2	4	1	5	0	1	6	...	17	...	11	...	0	...	0	2	4	17	0	0	1	2	0	3	3
Oct.	1	21	3	1	0	2	0	0	3	...	16	...	13	...	0	...	1	1	0	30	0	0	0	0	0	1	0
Nov.	0	22	2	1	0	2	0	1	2	...	19	...	10	...	0	...	0	1	15	14	0	0	0	1	0	0	0
Dec.	1	15	3	2	1	3	0	1	5	...	23	...	7	...	0	...	0	1	3	28	0	0	0	0	0	0	0
Year	20	148	25	21	7	64	4	10	66	...	186	...	119	...	21	...	15	24	...	...	...	...	...	...	...	...	...

Month.	TUGUEGARAS. Lat. 17° 37′. Long. 121° 30′. Height 125 ft. 8¼ Years (?). Hours (?)									MANILA. Lat. 14° 35′. Long. 120° 57′. Height 52 ft. 6 Years, 1866–71. Hours various.									ILO ILO. Lat. 10° 50′. Long. 122° 42′. Height (?) ft. 5 Years, 1868–72. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	2	5	2	0	1	19	0	6	5	5	2	1	2	4	3	3	0	28	...	0	...	0	0	0	3
Feb.	2	0	1	3	3	0	1	18	0	3	5	6	3	1	2	4	1	3	0	28	...	0	...	0	0	0	0
March	0	0	0	1	2	2	0	26	0	1	5	9	4	1	3	4	2	2	0	27	...	1	...	1	0	2	0
April	1	1	0	0	5	1	0	22	0	1	4	8	6	1	2	4	2	2	0	24	...	1	...	3	0	2	0
May	1	0	2	3	1	0	2	21	1	2	3	5	6	2	6	4	2	1	0	12	...	1	...	13	1	3	1
June	2	5	0	1	5	1	3	13	0	2	2	5	5	2	7	3	2	2	0	7	...	1	...	22	0	0	0
July	2	0	1	3	4	4	0	17	0	3	3	3	2	3	8	3	3	3	0	4	...	0	...	27	0	0	0
Aug.	3	0	0	4	4	0	2	18	0	3	2	2	3	3	11	3	2	2	0	4	...	0	...	27	0	0	1
Sept.	5	1	0	1	2	2	2	17	0	2	2	2	2	2	10	4	3	3	0	3	...	0	...	26	0	0	1
Oct.	4	1	1	3	3	1	0	17	1	5	4	3	2	2	6	3	2	4	5	11	...	0	...	13	0	1	1
Nov.	7	0	2	2	1	1	2	13	2	8	5	3	1	1	3	3	5	1	0	22	...	0	...	7	0	0	1
Dec.	7	0	1	3	1	0	3	15	1	9	5	4	2	1	2	2	3	3	1	22	...	0	...	2	0	4	2
Year	36	8	10	29	33	12	16	216	5	45	45	55	38	20	62	41	30	29	6	192	...	4	...	141	1	12	9

AMBOINA. Lat. —3° 45′ Long. 128° 15′. Height 39 ft. 5 Years, 1850–54. Hours 6, 9 : 3, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	5	2	1	1	2	4	6	6
Feb.	5	5	1	1	0	2	7	7	0
March	2	5	1	2	1	3	5	9	3
April	3	3	4	5	2	3	4	2	4
May	1	3	11	7	1	1	2	1	4
June	0	5	8	4	0	4	1	1	7
July	0	5	12	8	1	0	1	1	3
Aug.	1	4	8	14	1	0	0	1	2
Sept.	0	1	6	17	2	1	0	0	3
Oct.	1	0	6	14	2	2	2	0	4
Nov.	0	0	5	10	2	4	2	3	4
Dec.	3	2	2	4	1	6	4	3	6
Year	20	38	66	87	14	28	32	34	46

ANDEI, NEW GUINEA. Lat. —1° 0′. Long. 134° 0′. Height (?) ft. 1 Year, 1873–74. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	0	2	0	14	1	10	1
Feb.	0	0	0	5	0	20	0	2	1
March	0	3	0	11	1	13	0	3	0
April	0	7	1	3	0	12	0	6	1
May	0	4	17	3	0	2	5	0	0
June	0	2	17	3	0	0	1	0	1
July	0	0	23	1	0	0	1	0	6
Aug.	0	0	21	3	0	3	1	0	3
Sept.	0	5	18	3	0	2	0	0	2
Oct.	1	1	11	5	1	4	1	1	3
Nov.	0	1	6	9	1	8	4	1	0
Dec.	0	1	1	3	1	12	10	3	0
Year	2	26	115	51	4	90	24	26	18

BISMARCK-ARCHIPELS. Lat. —4° 20′. Long. 152° 30′. Height (?) ft. 2 Years, 1883–84. Hours Thrice daily.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	2	4	1	0	2	16	...
Feb.	4	1	1	0	0	0	0	22	...
March	4	0	1	4	0	0	1	21	...
April	3	4	4	10	1	0	0	8	...
May	3	3	5	18	0	1	0	1	...
June	0	1	4	25	0	0	0	0	...
July	1	1	5	22	1	0	0	1	...
Aug.	1	0	2	23	4	0	0	1	...
Sept.	1	3	9	15	0	0	1	1	...
Oct.	1	8	2	17	1	0	0	2	...
Nov.	4	9	5	5	0	0	0	7	...
Dec.	6	4	2	2	0	0	0	17	...
Year	33	35	42	145	8	1	4	97	..

BATAVIA. Lat. —6° 11′. Long. 106° 50′. Height 23 ft. 4 Years, 1879–82. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	0	0	0	4	9	8	7
Feb.	4	1	0	0	1	2	5	8	7
March	3	2	0	0	1	3	5	6	11
April	5	5	2	1	2	2	2	2	9
May	6	5	2	1	1	2	2	2	10
June	3	4	3	1	2	3	3	2	9
July	6	7	3	1	1	1	2	2	8
Aug.	6	9	3	1	1	1	1	1	8
Sept.	7	6	3	2	1	1	1	2	7
Oct.	6	5	2	1	1	3	3	2	8
Nov.	5	3	2	1	1	3	3	3	9
Dec.	2	1	0	0	1	2	7	7	11
Year	55	49	20	9	13	27	43	45	104

BANKOK. Lat. 13° 38′. Long. 100° 27′. Height (?) ft. 11 Years, 1858–68. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	6	5	2	4	3	1	1	...
Feb.	2	3	3	3	10	6	1	0	...
March	1	1	1	3	16	8	1	0	...
April	1	1	1	3	13	8	2	1	...
May	1	1	1	2	12	10	3	1	...
June	0	0	0	1	9	15	4	1	...
July	1	0	0	1	9	16	3	1	...
Aug.	0	0	1	1	7	16	5	1	...
Sept.	2	1	1	1	7	11	5	2	...
Oct.	8	5	3	2	3	5	3	2	...
Nov.	16	7	3	1	1	0	0	2	...
Dec.	17	9	2	1	0	0	0	2	...
Year	58	34	21	21	91	98	28	14	...

SINGAPORE. Lat. 1° 15′. Long. 103° 51′. Height 110 ft. 5 Years, 1880–84. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	12	1	2	1	1	1	8	5	...
Feb.	11	7	3	1	0	1	4	1	...
March	7	4	3	1	2	1	11	2	...
April	6	2	3	2	3	2	9	3	...
May	5	2	1	3	4	2	13	1	...
June	1	3	1	3	3	2	17	0	...
July	0	3	1	3	3	2	18	1	...
Aug.	1	0	1	2	2	5	19	1	...
Sept.	0	0	0	1	3	6	19	1	...
Oct.	2	0	0	1	1	3	21	3	...
Nov.	3	1	0	0	2	1	20	3	...
Dec.	7	3	1	1	1	0	15	3	...
Year	55	26	16	19	25	26	174	24	...

MOSUL. Lat. 36° 22′. Long. 43° 14′. Height 400 ft. 2 Years, 1854–55. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	7	4	3	1	2	5	2
Feb.	2	3	7	6	2	1	2	5	0
March	3	4	5	3	3	4	2	7	0
April	8	1	1	8	4	0	1	6	1
May	8	5	2	1	2	1	0	10	2
June	8	8	0	0	1	4	3	4	2
July	5	4	2	0	1	0	6	9	4
Aug.	8	4	1	0	2	5	2	9	0
Sept.	9	3	2	2	0	2	1	10	1
Oct.	6	2	0	4	4	4	1	7	3
Nov.	6	3	2	1	4	2	2	10	0
Dec.	5	3	3	5	5	1	3	6	0
Year	72	43	32	34	31	25	25	88	15

DJEDDA. Lat. 21° 30′. Long. 39° 22′. Height 20 ft. 4 Years, 1883–86. Hours 9 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	11	3	1	1	4	3	2	6	...
Feb.	14	2	1	0	2	2	5	2	...
March	12	1	3	0	4	1	5	5	...
April	12	1	1	0	8	2	4	2	...
May	15	1	0	1	2	1	4	7	...
June	15	2	0	0	1	0	4	8	...
July	12	1	1	1	1	1	7	7	...
Aug.	12	1	0	1	1	1	8	7	...
Sept.	7	1	1	1	0	1	5	14	...
Oct.	8	1	2	1	2	3	8	6	...
Nov.	11	1	1	1	2	1	7	6	...
Dec.	7	1	4	1	3	3	7	5	...
Year	136	16	15	8	30	19	66	75	...

JERUSALEM. Lat 31° 47′. Long. 35° 13. Height 2500 ft. 18 Years, 1864–81. Hour 9 :

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	6	2	1	6	5	5	...
Feb.	1	3	4	2	2	6	4	6	...
March	1	2	4	4	2	6	6	6	...
April	2	1	3	5	2	5	5	7	...
May	4	3	3	4	1	2	4	10	...
June	4	2	2	2	0	3	5	12	...
July	3	1	0	1	0	2	6	18	...
Aug.	3	1	0	1	1	2	6	17	...
Sept.	7	2	1	1	1	1	5	12	...
Oct.	5	4	5	3	1	2	2	9	...
Nov.	2	5	7	2	1	4	4	5	...
Dec.	1	4	5	3	2	6	4	6	...
Year	34	33	40	30	14	45	56	113	...

Month.	BEYROUT, SYRIA. Lat. 33° 54′. Long. 35° 29′. Height 160 ft. 9 Years, 1846–54. Hours 8, N. : 6.									BEYROUT. Lat. 33° 54′. Long. 35° 29′. Height 112 ft. 10 Years, 1877–85. Hours 8 : 2, 8.									TREBISONDE. Lat. 41° 1′. Long. 39° 45′. Height 92 ft. Hours 9.20 : 3.20, 9.20. 6⅓ Years, 1879–85.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	0	0	3	11	9	2	...	3	3	2	10	3	6	2	2	0	3	1	4	3	6	4	3	6	1
Feb.	4	0	1	0	5	7	7	4	...	2	3	2	8	3	6	2	1	1	2	1	6	3	4	3	3	5	1
March	9	1	1	0	3	10	4	3	...	4	5	2	3	2	9	3	2	1	3	1	8	3	3	3	4	5	1
April	8	1	0	1	2	6	10	2	...	4	4	1	2	2	11	3	2	1	4	2	10	3	2	2	2	4	1
May	8	4	0	1	1	7	7	3	...	4	4	1	1	2	11	4	3	1	4	2	12	2	2	1	1	6	1
June	5	0	0	0	0	10	10	5	...	3	1	0	0	1	14	6	3	2	3	2	10	2	2	1	2	6	2
July	1	1	0	0	1	8	15	5	...	1	0	0	0	1	18	8	2	1	4	2	6	2	3	2	2	8	2
Aug.	3	0	0	0	1	11	13	3	...	3	1	0	0	1	13	7	3	3	3	2	6	2	4	3	3	7	1
Sept.	7	0	0	0	3	4	11	5	...	5	3	0	0	2	10	6	3	1	3	1	6	2	5	3	2	7	1
Oct.	10	3	0	0	1	3	7	7	...	5	7	1	2	2	8	2	2	2	2	1	6	3	5	4	3	6	1
Nov.	8	1	1	0	1	3	9	7	...	3	4	1	7	2	7	3	2	1	2	1	4	3	6	5	4	3	2
Dec.	4	1	0	1	2	8	12	3	...	2	3	2	9	3	7	3	1	1	1	1	4	4	6	5	5	4	1
Year	72	13	3	3	23	88	114	49	...	39	38	12	42	24	120	49	26	15	34	17	82	32	48	36	34	67	15

Month.	SAMSOUN. Lat. 41° 18′. Long. 36° 19′. Height 26 ft. 6 Years, 1880–85. Hours : 2.36, 9.9									SCUTARI. Lat. 41° 0′. Long. 29° 3′. Height 60 ft. 15 Years, 1870–84. Hours 9 : 3.									SMYRNA. Lat. 38° 26′. Long. 27° 10′. Height 25 ft. 6½ Years, 1864–70. Hours 7 : 2, 10.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	3	0	6	2	9	0	11	0	6	9	4	2	3	4	1	1	1									
Feb.	0	6	0	2	1	6	0	13	0	5	8	4	1	3	4	1	1	1	2	13	5	4	3	1	1	1	1
March	1	6	0	7	2	3	0	12	0	5	8	2	1	5	5	2	1	2									
April	1	8	0	4	2	2	0	13	0	4	9	1	1	5	6	2	0	2									
May	0	10	0	6	2	2	0	11	0	5	9	1	0	5	7	2	0	2	1	5	3	6	4	5	3	1	3
June	0	11	1	5	1	0	0	12	0	4	9	1	0	5	9	1	0	1									
July	1	9	1	2	2	1	1	14	0	5	15	2	0	3	4	0	1	1									
Aug.	0	10	1	3	2	0	0	14	1	4	15	3	0	3	4	1	0	1	2	5	1	2	2	7	4	3	5
Sept.	1	8	1	3	1	0	0	15	1	4	12	4	0	2	5	1	1	1									
Oct.	1	8	0	5	2	3	0	11	1	4	10	4	1	2	6	1	0	3									
Nov.	1	5	0	6	1	4	0	13	0	4	8	4	2	3	5	1	1	2	1	6	4	2	3	6	3	2	4
Dec.	0	4	0	6	2	9	0	10	0	5	7	4	2	3	6	1	1	2									
Year	6	88	4	55	20	39	1	149	3	65	119	34	10	42	65	14	7	19	...	...	...	...	...	...	...	...	...

Month.	CHIOS. Lat. 38° 22′. Long. 26° 6′. Height (?) ft. Years, (?) Hours (?)									RED SEA.* Lat. 28° to 30°. Square 105.									RED SEA. Long. 48° to 50°. Square 68.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.										12	2	1	1	2	1	1	10	1	2	11	15	2	0	0	0	0	1
Feb.	10	2	0	1	10	3	1	0	3	9	2	0	1	3	2	2	7	2	2	9	15	1	0	0	0	0	1
March										10	2	0	3	3	1	1	8	3	1	9	16	1	1	0	0	1	2
April										14	2	0	1	1	0	1	6	3	2	8	15	2	0	0	1	0	2
May	11	1	1	1	11	3	0	0	3	14	1	0	0	0	0	1	13	2	2	4	7	3	2	3	3	1	6
June										16	1	0	0	1	0	1	10	1	2	1	1	2	3	9	7	2	3
July										13	2	0	1	0	1	0	14	0	1	0	1	1	5	11	8	1	3
Aug.	18	5	0	0	3	1	0	1	3	16	1	0	0	0	0	0	13	1	2	2	2	2	4	7	6	2	4
Sept.										16	1	0	0	0	1	0	12	0	2	2	4	3	3	6	3	1	6
Oct.										12	2	0	1	0	0	1	13	2	2	8	11	1	0	1	0	1	7
Nov.	15	3	0	0	7	2	0	1	3	11	1	0	1	1	1	1	12	2	1	9	13	2	0	1	0	1	3
Dec.										11	1	1	1	2	0	3	10	3	1	11	17	1	0	0	0	0	1
Year	...	...	...	...	...	...	...	...	...	154	18	2	10	13	7	12	139	20	20	74	117	21	18	38	28	10	39

* The following twelve Tables referring to the Red Sea are constructed from the observations of ships' logs. For these means the author is indebted to the courtesy of the Meteorological Council.

RED SEA. Long. 44° to 46°. Square 68.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	15	7	1	1	0	0	2
Feb.	0	6	17	4	0	1	0	0	0
March	0	6	17	4	1	1	0	0	2
April	0	6	14	7	1	1	0	0	1
May	1	4	10	4	3	3	2	1	3
June	1	1	3	3	5	7	4	2	4
July	1	1	1	1	5	11	6	1	4
Aug.	1	1	1	3	6	9	5	1	4
Sept.	1	2	6	4	4	5	2	1	5
Oct.	1	6	12	6	2	0	1	0	3
Nov.	1	4	17	5	2	0	0	0	1
Dec.	0	5	18	6	1	0	0	0	1
Year	8	46	131	54	31	39	20	6	30

RED SEA. Long. 46° to 48°. Square 68.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	7	19	2	1	0	0	0	1
Feb.	1	8	18	1	0	0	0	0	0
March	1	8	17	1	1	1	0	0	2
April	0	9	16	1	1	0	0	1	2
May	1	5	9	3	1	3	2	1	6
June	1	1	1	2	5	10	5	1	4
July	1	0	1	1	4	15	7	0	2
Aug.	2	1	1	2	6	9	7	1	2
Sept.	2	2	3	5	2	5	3	2	6
Oct.	1	7	13	3	1	1	2	0	3
Nov.	1	8	17	3	0	0	0	0	1
Dec.	1	7	20	2	0	0	0	0	1
Year	13	63	135	26	22	44	26	6	30

RED SEA. Lat. 14° to 16°. Squares 69 and 68.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	9	8	1	1	5	2
Feb.	3	1	1	8	10	1	0	3	1
March	3	2	2	7	10	2	0	3	2
April	3	1	2	8	8	1	1	3	3
May	5	2	0	5	4	2	2	7	4
June	7	1	1	0	1	2	2	10	6
July	8	1	1	1	1	1	3	12	3
Aug.	5	2	2	3	2	1	1	10	5
Sept.	5	4	1	3	2	2	3	6	4
Oct.	1	1	0	9	10	1	1	2	6
Nov.	1	0	1	11	13	1	0	1	2
Dec.	1	0	1	12	13	1	0	1	2
Year	45	16	13	76	82	16	14	63	40

RED SEA. Long. 42° to 44°. Square 68.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	5	14	9	0	0	1	0
Feb.	2	0	3	10	9	1	1	2	0
March	1	1	2	11	11	2	0	2	1
April	2	0	3	10	10	1	1	2	1
May	2	0	2	8	8	2	3	4	2
June	5	1	1	2	1	2	2	13	3
July	5	1	1	1	1	3	5	12	2
Aug.	5	2	2	3	3	2	4	8	2
Sept.	5	2	3	4	3	2	2	4	5
Oct.	1	0	3	12	13	0	1	0	1
Nov.	0	1	3	14	11	0	0	1	0
Dec.	1	0	3	14	12	0	0	0	1
Year	30	9	31	103	91	15	19	49	18

RED SEA. Lat. 16° to 18°. Squares 69 and 68.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	15	5	1	0	3	2
Feb.	4	2	2	8	4	1	0	4	3
March	7	2	3	8	2	0	1	6	2
April	4	3	2	10	1	1	1	4	4
May	5	2	1	7	1	1	3	8	3
June	7	1	1	1	0	1	1	15	3
July	8	1	0	1	0	1	3	13	4
Aug.	6	1	1	1	4	2	1	9	6
Sept.	7	3	2	2	1	2	2	8	3
Oct.	4	1	3	7	5	2	1	2	6
Nov.	2	1	3	13	6	1	0	0	4
Dec.	2	1	3	13	6	0	1	1	4
Year	59	19	22	86	35	13	14	73	44

RED SEA. Lat. 24° to 26°. Square 105.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	13	4	1	0	0	1	1	10	1
Feb.	9	2	2	2	1	1	1	8	2
March	11	3	1	2	2	1	1	8	2
April	9	1	1	2	2	0	1	11	3
May	9	1	1	0	1	1	1	15	2
June	9	0	0	0	1	0	2	16	2
July	9	1	0	0	1	1	2	13	4
Aug.	9	1	0	0	1	1	1	16	2
Sept.	10	1	0	0	1	0	1	16	1
Oct.	10	2	0	1	1	0	1	13	3
Nov.	12	1	1	1	1	0	0	11	3
Dec.	12	2	2	2	1	0	1	10	1
Year	122	19	9	10	13	6	13	147	26

RED SEA. Lat 26° to 28°. Square 105.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	12	1	1	1	0	0	1	13	2
Feb.	6	1	1	2	1	1	2	13	1
March	9	1	1	1	1	1	1	14	2
April	9	1	1	2	1	1	1	12	2
May	8	0	1	1	0	0	1	17	3
June	8	0	0	1	0	0	1	19	1
July	9	1	0	0	0	0	2	17	2
Aug.	10	0	1	0	0	0	2	17	1
Sept.	9	0	0	0	1	0	1	19	0
Oct.	9	1	0	0	1	0	1	16	3
Nov.	9	0	1	1	1	0	2	14	2
Dec.	9	1	1	1	1	1	1	15	1
Year	107	7	8	10	7	4	16	186	20

RED SEA. Lat. 22° to 24°. Square 105.

Month.	N.	N.E	E.	S.E.	S.	S W	W.	N.W	CA.
Jan.	14	3	1	1	1	0	1	9	1
Feb.	10	2	2	3	1	0	1	7	2
March	12	2	1	3	1	0	1	10	1
April	10	1	2	1	1	1	1	11	2
May	10	1	1	0	1	1	1	13	3
June	7	2	1	1	0	1	3	11	4
July	8	2	0	1	0	1	3	12	4
Aug.	9	0	0	1	1	1	1	17	1
Sept.	10	1	0	0	0	1	1	17	0
Oct.	11	1	1	2	1	1	1	9	4
Nov.	10	2	3	5	1	0	0	7	2
Dec.	11	4	2	2	1	1	1	6	3
Year	122	21	14	20	9	8	15	129	27

RED SEA. Lat. 20° to 22°. Square 105.

Month.	N.	N. E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	16	5	1	2	0	0	0	5	2
Feb.	12	4	1	2	2	0	0	6	1
March	13	4	1	3	2	0	0	7	1
April	11	2	2	2	1	1	1	6	4
May	11	2	0	1	1	1	1	10	4
June	11	1	0	0	0	0	2	14	2
July	7	2	1	1	1	2	3	11	3
Aug.	5	1	1	2	2	3	4	12	1
Sept.	11	1	1	1	0	1	1	13	1
Oct.	9	2	1	3	2	1	1	8	4
Nov.	10	2	3	5	3	1	0	3	3
Dec.	11	4	3	4	1	0	1	5	2
Year	127	30	15	26	15	10	14	100	28

Month.	RED SEA. Lat. 18° to 20°. Squares 69 and 68.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	3	2	8	1	1	0	5	3
Feb.	11	3	2	4	1	1	0	5	1
March	9	2	3	6	1	0	1	6	3
April	9	3	3	4	2	0	0	7	2
May	8	2	2	2	1	1	1	11	3
June	8	1	0	1	1	1	4	13	1
July	5	1	0	0	1	3	5	13	3
Aug.	2	1	0	1	3	4	7	11	2
Sept.	7	1	1	1	1	2	3	12	2
Oct.	6	2	2	5	3	1	1	4	7
Nov.	4	3	5	9	4	1	0	1	3
Dec.	5	3	4	11	3	0	0	2	3
Year	82	25	24	52	22	15	22	90	33

Month.	MASSUAH. Lat. 15° 36′. Long. 39° 20′. Height 31 ft. 1¾ Years, 1886–87. Hours 9 : 4.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	13	3	0	0	0	0	2	3
Feb.	13	6	4	0	0	1	1	1	2
March	12	16	2	0	0	0	0	1	0
April	15	10	3	0	0	0	0	1	1
May	20	10	1	0	0	0	0	0	0
June	16	7	2	0	1	0	0	0	4
July	15	8	3	1	1	0	2	1	0
Aug.	9	6	4	0	1	0	1	0	0
Sept.	11	18	0	0	0	0	0	1	0
Oct.	13	17	0	0	0	0	0	1	0
Nov.	14	15	1	0	0	0	0	0	0
Dec.	19	10	1	0	0	0	0	0	1
Year	167	136	24	1	3	1	4	8	11

Month.	KOSSEIR. Lat. 26° 5′. Long. 34° 16′. Height (?) ft. 1 Year, 1872–73. Hours S.-R., : 1.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	3	1	0	0	0	13	4	...
Feb.	7	0	0	2	0	1	13	5	...
March	10	0	0	5	0	0	10	6	...
April	10	3	3	2	0	0	4	8	...
May	13	2	0	1	0	0	5	10	...
June	17	1	0	1	0	0	0	11	...
July	13	1	1	0	0	0	3	13	...
Aug.	15	1	0	2	0	1	1	11	...
Sept.	17	1	0	0	0	0	0	12	...
Oct.	15	1	0	0	0	0	0	15	...
Nov.	12	2	0	0	0	0	9	7	...
Dec.	9	3	2	0	0	0	12	5	...
Year	148	18	7	13	0	2	70	107	...

Month.	SUEZ. Lat. 29° 59′. Long. 32° 31′. Height 24 ft. 5½ Years, 1880–85. Hours 7, 8, 11 : 2, 5.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	2	0	2	7	3	1	4	2
Feb.	5	1	0	1	5	7	2	6	1
March	11	1	0	1	5	3	1	9	0
April	10	1	0	1	6	3	1	8	0
May	16	1	0	0	2	1	0	10	1
June	15	1	0	0	1	1	0	11	1
July	15	3	0	0	0	1	0	10	2
Aug.	13	2	0	0	0	0	0	12	4
Sept.	17	1	0	0	1	0	0	8	3
Oct.	15	1	1	0	0	1	0	9	4
Nov.	14	1	0	1	1	2	0	7	4
Dec.	9	1	0	1	6	3	1	8	2
Year	150	16	1	7	34	25	6	102	24

Month.	ISMAILIA. Lat. 30° 36′. Long. 32° 16′. Height 29 ft. 5½ Years, 1880–85. Hours 7 : 2, 6.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	2	1	3	11	3	2
Feb.	4	3	1	1	2	4	9	3	1
March	8	4	2	2	2	2	5	4	2
April	7	5	3	2	1	1	7	3	1
May	12	6	2	1	1	1	4	4	0
June	14	6	2	1	0	1	2	3	1
July	15	2	1	0	1	1	4	6	1
Aug.	17	3	1	0	0	0	4	5	1
Sept.	17	3	1	0	0	1	3	4	1
Oct.	16	6	2	0	0	0	2	3	2
Nov.	9	5	1	1	1	2	5	5	1
Dec.	6	3	3	1	1	3	8	4	2
Year	129	49	21	11	10	19	64	47	15

Month.	SAID. Lat. 31° 16′. Long. 32° 18′. Height 20 ft. 5½ Years, 1880–85. Hours 7 : 2, 5.								
	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	2	1	3	6	10	3	1
Feb.	3	2	1	1	2	5	10	4	0
March	6	5	2	1	2	2	5	7	1
April	5	6	2	1	2	2	4	8	0
May	9	6	3	0	1	1	3	7	1
June	9	5	2	0	1	1	2	9	1
July	7	3	2	0	0	1	5	12	1
Aug.	8	3	2	0	0	0	4	13	1
Sept.	7	4	2	0	0	0	3	13	1
Oct.	8	8	3	1	0	1	2	7	1
Nov.	6	4	2	1	1	3	6	6	1
Dec.	3	4	1	1	3	6	7	4	2
Year	73	53	24	7	15	28	61	93	11

Month.	CAIRO. Lat. 30° 5′. Long. 31° 17′. Height 94 ft. (?) Years. Hours 7 : 2, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	1	1	4	3	5	2	9
Feb.	5	2	0	1	3	2	3	3	9
March	7	2	1	0	1	1	3	4	12
April	10	3	1	1	1	1	2	4	7
May	10	3	1	0	1	1	1	9	5
June	9	2	0	0	0	0	2	13	4
July	10	2	0	0	0	0	2	14	3
Aug.	10	1	0	0	0	0	2	13	5
Sept.	10	2	0	0	0	0	0	14	4
Oct.	10	3	0	0	0	0	1	11	6
Nov.	8	1	0	0	2	1	1	7	10
Dec.	4	1	0	1	6	2	3	2	12
Year	97	24	4	4	18	11	25	96	86

Month.	ALEXANDRIA. Lat. 31° 12′. Long. 29° 53′. Height 62 ft. 9 Years, 1875–83. Hours 9 : 3, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	4	2	3	4	4	6	2
Feb.	5	2	3	2	2	2	4	7	1
March	7	4	3	2	2	1	3	8	1
April	9	4	3	2	1	1	2	7	1
May	13	3	2	1	1	1	1	8	1
June	13	2	1	0	1	0	1	11	1
July	12	1	0	0	0	0	2	16	0
Aug.	13	1	0	0	0	0	2	14	1
Sept.	15	2	1	0	0	0	1	8	3
Oct.	12	5	3	1	1	1	1	5	2
Nov.	8	4	3	2	2	2	2	5	2
Dec.	6	3	3	2	3	4	3	5	2
Year	117	33	26	14	16	16	26	100	17

Month.	BENGASI. Lat. 32° 7′. Long. 20° 3′. Height 33 ft. 1 Year, 1882. Hours 9 : 3.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	9	4	5	3	2	1	3	...
Feb.	7	5	1	3	2	3	3	4	...
March	7	5	1	1	5	3	6	3	...
April	8	3	0	0	5	2	5	7	...
May	11	9	0	1	2	2	1	5	...
June	16	7	0	0	4	1	1	1	...
July	15	7	0	1	0	1	0	7	...
Aug.	13	6	0	1	0	1	3	7	...
Sept.	8	7	2	2	4	3	2	2	...
Oct.	6	7	2	3	4	2	2	5	...
Nov.	5	4	2	4	7	3	4	1	...
Dec.	3	1	3	2	9	5	5	3	...
Year	103	70	15	23	45	28	33	48	...

TRIPOLI. Lat. 32° 53′. Long. 13° 11′. Height 98 ft. 6 Years, 1879–85. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	4	2	2	1	1	6	8	0
Feb.	7	4	5	1	1	0	6	4	0
March	6	5	8	2	2	1	4	3	0
April	5	4	8	2	2	0	4	5	0
May	7	5	13	2	0	0	1	2	1
June	6	5	16	1	0	0	1	1	0
July	5	8	15	1	0	0	1	1	0
Aug.	4	9	12	0	1	0	2	2	1
Sept.	3	9	13	1	1	0	1	2	0
Oct.	7	7	8	1	1	0	3	4	0
Nov.	6	4	6	2	0	1	6	5	0
Dec.	7	3	3	2	1	0	7	8	0
Year	70	67	109	17	10	3	42	45	2

LA CALLE. Lat. 36° 54′. Long. 8° 26′. Height 35 ft. Hours 7: 1, 7. 6 Years, 1878–79, 81–84.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	1	2	7	7	9	0
Feb.	2	2	3	1	3	5	5	7	0
March	2	2	4	0	3	6	6	8	0
April	4	2	3	0	2	4	5	10	0
May	4	5	4	1	2	3	4	8	0
June	6	5	4	1	1	3	3	6	1
July	6	6	4	1	2	4	3	4	1
Aug.	6	7	4	0	2	4	3	4	1
Sept.	5	4	4	0	2	5	4	6	0
Oct.	5	2	3	1	3	7	4	5	1
Nov.	2	2	2	1	4	8	7	4	0
Dec.	3	1	2	1	3	7	9	5	0
Year	47	39	39	8	29	63	60	76	4

ALGIERS. Lat. 36° 47′. Long. 3° 4′. Height 73 ft. 7 Years, 1878–84. Hours 7: 1, 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	1	1	5	7	7	1
Feb.	3	2	1	1	1	4	8	8	0
March	3	6	2	2	1	4	5	7	1
April	4	2	1	1	0	5	7	10	0
May	4	7	3	1	1	2	4	8	1
June	5	10	2	2	1	2	2	5	1
July	6	12	3	1	0	2	2	4	1
Aug.	7	9	2	1	1	3	2	5	1
Sept.	6	6	3	1	1	2	3	7	1
Oct.	4	6	2	1	1	3	5	8	1
Nov.	3	3	2	1	1	7	5	8	0
Dec.	3	2	1	1	1	8	7	8	0
Year	52	68	24	14	10	47	57	85	8

LAGHOUAT. Lat. 33° 48′. Long. 2° 51′. Height 2454 ft. 7 Years, 1878–84. Hours 7: 1, 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	3	2	3	3	5	4	5
Feb.	4	3	2	2	3	3	4	4	3
March	4	3	5	3	3	3	4	3	3
April	4	3	2	2	3	2	6	6	2
May	4	4	5	2	5	1	4	3	3
June	4	4	8	2	3	1	3	2	3
July	2	4	7	3	4	2	4	3	2
Aug.	3	5	6	3	4	2	3	2	3
Sept.	4	3	4	3	4	3	4	2	3
Oct.	5	3	3	3	4	4	4	2	3
Nov.	6	4	4	2	3	3	2	4	2
Dec.	5	4	3	2	3	3	2	6	3
Year	49	42	52	29	42	30	45	41	35

ORAN. Lat. 35° 42′. Long. — 0° 39′. Height 164 ft. 12 Years, 1841–53. Hour: 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	1	2	4	9	2	7	...
Feb.	6	6	1	1	2	6	2	4	...
March	6	8	1	1	1	7	1	6	...
April	8	7	1	1	1	4	1	7	...
May	9	7	0	1	1	4	1	8	...
June	9	8	0	1	1	2	0	9	...
July	10	7	0	0	1	0	1	12	...
Aug.	10	8	0	1	0	1	0	11	...
Sept.	8	7	0	1	0	1	1	12	...
Oct.	6	7	0	1	2	4	1	10	...
Nov.	4	7	0	2	2	7	2	6	...
Dec.	3	5	0	3	3	10	1	6	...
Year	83	79	4	15	18	55	13	98	...

NEMOURS. Lat. 35° 6′. Long. —1° 51′. Height 13 ft. 7 Years, 1878–84. Hours 7: 1, 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	4	4	3	1	7	3	4
Feb.	3	1	3	4	3	2	5	3	4
March	4	1	7	3	3	1	6	3	3
April	3	1	5	4	3	1	7	3	3
May	4	2	5	4	3	1	4	3	5
June	6	2	5	2	2	1	2	2	8
July	6	2	5	2	2	1	2	2	9
Aug.	6	0	5	3	2	1	2	4	8
Sept.	8	1	6	2	3	1	2	3	4
Oct.	5	1	6	3	4	1	4	3	4
Nov.	5	1	5	3	3	2	7	2	2
Dec.	6	3	6	2	3	1	5	2	3
Year	60	16	62	36	34	14	53	33	57

TANGIER. Lat. 35° 45′. Long. —5° 47′. Height 200 ft. 6 Years, 1880–85. Hours 7, N.: 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	7	1	0	6	10	3	...
Feb.	2	2	7	1	0	5	7	4	...
March	1	2	8	1	2	6	8	3	...
April	1	3	2	1	1	7	11	4	...
May	3	3	6	0	0	4	9	6	...
June	2	5	5	0	0	4	11	3	...
July	3	4	8	0	2	3	8	3	...
Aug.	1	3	10	0	2	3	8	4	...
Sept.	3	2	8	1	1	4	7	4	...
Oct.	3	3	4	1	2	6	8	4	...
Nov.	3	5	5	1	0	4	8	4	...
Dec.	2	3	4	1	0	9	8	4	...
Year	26	37	74	8	10	61	103	46	...

MOGADOR. Lat. 31° 30′. Long. —9° 44′. Height 57 ft. Hours 8: 2, 10. 7 Years, 1866–71, 78–79.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	15	2	0	2	2	3	0	6
Feb.	0	14	0	1	1	2	3	1	6
March	1	16	0	0	0	1	4	0	9
April	1	15	0	1	1	0	3	0	9
May	1	20	0	0	0	1	2	0	7
June	1	17	0	0	1	0	3	0	8
July	0	28	0	0	0	0	0	0	3
Aug.	0	24	1	0	0	0	0	0	6
Sept.	0	20	0	0	0	0	0	0	9
Oct.	0	15	0	0	0	0	1	0	14
Nov.	0	9	0	0	0	1	1	0	15
Dec.	2	9	1	0	1	2	3	0	13
Year	7	202	4	2	7	12	25	1	105

ST. MICHAEL, AZORES. Lat. 37° 35′. Long. —25° 30′. Height (?) ft. 10 Years, 1840–49. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	8	1	4	3	6	1	6	0
Feb.	1	6	1	4	1	7	1	7	0
March	1	7	1	3	2	9	2	6	0
April	1	9	2	2	1	4	2	8	0
May	2	10	1	3	1	4	2	8	0
June	1	10	1	3	1	4	2	8	0
July	2	13	1	3	0	5	2	5	0
Aug.	0	15	0	5	0	3	2	5	1
Sept.	1	12	1	5	0	3	1	6	1
Oct.	2	10	1	4	2	4	1	5	1
Nov.	3	7	0	4	2	7	1	6	0
Dec.	3	8	2	4	2	5	2	7	0
Year	18	115	12	44	15	61	18	77	5

LAS PALMAS. Lat. 27° 28′. Long. —17° 48′. Height 30 ft. 4½ Years, 1880–84. Hours: 1, 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	4	9	4	1	1	1	5
Feb.	7	4	5	3	2	0	0	4	3
March	10	5	4	3	1	1	1	3	3
April	14	7	2	2	2	1	0	1	1
May	12	3	2	1	2	2	1	3	5
June	11	2	1	0	0	1	3	7	5
July	12	3	1	1	2	2	2	6	2
Aug.	8	4	2	1	2	1	5	6	2
Sept.	6	7	2	0	2	2	2	4	5
Oct.	11	6	3	2	1	1	1	2	4
Nov.	5	5	6	3	4	3	1	1	2
Dec.	4	3	5	5	5	2	0	1	6
Year	102	53	37	30	27	17	17	39	43

CAPE JUBY. Lat. 27° 58′. Long. —12° 52′. Height 23 ft. 6 Years, 1883–88. Hours 9: 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	10	5	5	2	1	1	1	0
Feb.	8	10	2	2	1	2	1	2	0
March	9	12	0	1	1	1	2	4	0
April	12	10	1	0	0	1	3	3	0
May	13	17	0	0	0	0	0	1	0
June	13	16	0	0	0	0	0	1	0
July	10	21	0	0	0	0	0	0	0
Aug.	8	21	1	0	0	0	1	0	0
Sept.	8	19	1	0	0	0	0	1	1
Oct.	6	18	2	1	0	1	1	1	2
Nov.	6	11	3	3	2	3	1	1	0
Dec.	4	11	5	4	2	3	1	1	0
Year	103	176	20	16	8	12	11	16	3

PRAYA. Lat. 14° 54′. Long. —23° 31′. Height 112 ft. 5 Years, 1875–79. Hours 9: 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	15	11	0	1	0	0	0	1
Feb.	1	11	15	0	0	1	0	0	0
March	1	19	7	0	1	1	0	0	2
April	3	15	6	0	1	2	1	1	1
May	4	15	5	1	1	1	0	3	1
June	3	13	7	1	1	2	1	1	1
July	3	13	4	2	2	2	1	1	3
Aug.	2	10	5	3	3	3	1	1	3
Sept.	3	10	4	2	1	4	1	2	3
Oct.	2	13	10	2	1	1	0	0	2
Nov.	1	11	13	2	1	0	0	0	2
Dec.	1	10	13	1	1	2	1	1	1
Year	27	155	100	14	14	19	6	10	20

SAINT LOUIS. Lat. 16° 7′. Long —16° 30′. Height 16 ft. 5 Years, 1874–78. Hours 10: 4.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	6	8	0	0	0	0	6	1
Feb.	9	3	8	0	0	0	0	7	1
March	18	2	3	0	0	0	0	8	0
April	18	1	2	0	0	1	2	6	0
May	17	1	0	0	1	1	5	6	0
June	7	0	0	0	1	3	13	5	1
July	6	0	1	1	1	4	10	7	1
Aug.	5	0	1	1	3	3	9	7	2
Sept.	5	1	2	1	3	3	6	8	1
Oct.	14	1	3	1	1	0	4	6	1
Nov.	17	3	5	0	0	1	1	2	1
Dec.	14	7	6	0	0	0	1	3	0
Year	140	25	39	4	10	16	51	71	9

GORÉE. Lat. 14° 40′. Long. —17° 25′. Height 20 ft. 10 Years, 1856–65. Hours 6, 10: 1, 4, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	16	6	0	0	0	0	0	3
Feb.	6	13	7	0	0	0	0	0	2
March	8	16	4	0	0	0	0	1	2
April	11	12	3	0	0	0	0	1	3
May	12	8	1	0	0	1	2	2	5
June	5	6	1	0	1	2	6	5	4
July	4	3	0	1	2	3	9	5	4
Aug.	2	1	0	1	2	7	10	5	3
Sept.	4	3	1	3	3	5	4	3	4
Oct.	8	7	2	1	1	1	3	4	4
Nov.	9	10	3	0	0	1	1	2	4
Dec.	8	12	6	1	0	0	0	1	3
Year	83	107	34	7	9	20	35	29	41

MURZUK. Lat. 25° 54′. Long. 14° 12′. Height 1560 ft. Hours s.-r., 9: 3, s.-s. 6 Months, 1865–66.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	2	0	1	1	3	4	16
Feb.	2	0	1	1	1	3	4	2	14
March	1	1	3	1	4	2	3	1	15
April	...	...	...	...	...	...	...	...	..
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	4	1	4	3	7	3	2	1	6
Nov.	4	4	1	1	1	1	2	2	14
Dec.	5	1	2	0	1	2	6	4	10
Year	...	...	...	...	...	...	...	...	...

SCHIMMEDRU. Lat. 18° 57′. Long. 12° 10′. Height 1640 ft. 3 Months, 1866. Hours s.-r., 9: 3, s.-s.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...
April	6	3	3	2	4	0	0	2	10
May	1	1	3	1	5	1	1	0	18
June	2	2	4	4	3	1	1	1	12
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

GHADAMES. Lat. 30° 9′. Long. 9° 13′. Height 1323 ft. 2 Months, 1865. Hours s.-r., 9: 3, s.-s.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...
April	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	2	7	2	3	1	0	1	2	13
Aug.	1	3	5	2	2	0	0	1	17
Sept.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

KUKA. Lat. 12° 52′. Long. 13° 23′. Height 1168 ft. 6 Months, 1866. Hours, s.-r., 9: 3, s.-s.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...
April	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	1	0	1	0	3	10	3	0	13
Aug.	0	1	0	1	1	6	3	0	19
Sept.	0	1	3	6	2	2	2	1	13
Oct.	5	5	2	2	0	0	0	1	16
Nov.	3	2	10	0	0	0	0	0	15
Dec.	4	8	1	0	0	0	0	4	14
Year	...	...	...	...	...	...	...	...	...

BOKÉ. Lat. 10° 54′. Long. —14° 14′. Height 600 ft. 1 Year, 1878–79. Hours 6 : 3, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	10	3	1	0	13	1	...
Feb.	1	1	10	1	1	1	13	0	...
March	1	2	9	1	3	5	9	1	...
April	1	0	1	1	7	7	11	2	...
May	3	2	2	3	4	4	9	4	...
June	1	0	3	0	9	7	9	1	...
July	0	0	1	0	11	4	13	2	...
Aug.	0	0	1	0	10	7	11	2	...
Sept.	1	0	0	0	6	7	13	3	...
Oct.	3	1	6	3	3	4	11	0	...
Nov.	4	5	9	3	4	1	4	0	...
Dec.	0	2	11	3	5	1	8	1	...
Year	16	15	63	18	64	48	124	17	...

FREETOWN. Lat. 8° 30′. Long. —13° 9′. Height 224 ft. 11 Years, 1874–84. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	4	8	1	1	1	5	3	3
Feb.	5	2	4	1	2	2	7	3	2
March	8	2	1	0	3	3	8	5	1
April	7	2	2	1	2	3	9	3	1
May	5	2	5	1	2	3	8	3	2
June	4	1	5	1	3	2	8	3	3
July	4	1	2	1	3	4	10	2	4
Aug.	4	1	1	1	3	5	12	1	3
Sept.	3	1	2	0	3	4	12	1	4
Oct.	2	2	4	1	3	4	10	2	3
Nov.	2	2	6	1	2	2	8	2	5
Dec.	5	3	5	1	2	2	6	3	4
Year	54	23	45	10	29	35	103	31	35

AKASSA. Lat. 4° 20′. Long. 6° 20′. Height 21 ft. $1\frac{1}{3}$ Years, 1887–88. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	0	2	1	6	4	4	8
Feb.	0	2	1	1	1	6	1	1	15
March	0	1	0	1	6	3	0	1	19
April	2	2	1	1	3	2	0	0	19
May	...	...	...	...	...	...	...	...	...
June	1	0	0	2	9	9	1	0	8
July	0	0	0	1	10	17	0	1	2
Aug.	0	0	0	1	5	15	2	1	7
Sept.	1	0	0	0	2	12	5	1	9
Oct.	1	1	0	1	1	6	3	5	13
Nov.	1	2	1	4	3	8	2	1	8
Dec.	0	0	1	4	5	14	4	0	3
Year	...	...	...	...	...	...	...	...	...

ASCENSION. Lat. -7° 55′. Long. —14° 25. Height 53 ft. 2 Years, 1863–66. Hours 6, 9, N. : 4.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	2	9	17	1	0	0	2
Feb.	0	1	1	11	13	1	1	0	0
March	0	0	3	11	16	0	0	1	0
April	0	0	2	11	16	0	0	0	1
May	0	0	5	15	10	0	0	0	1
June	0	0	3	15	11	0	0	0	1
July	0	0	4	17	10	0	0	0	0
Aug.	0	0	3	18	10	0	0	0	0
Sept.	0	0	3	17	10	0	0	0	0
Oct.	0	1	2	22	6	0	0	0	0
Nov.	0	0	2	12	16	0	0	0	0
Dec.	0	0	1	9	20	0	0	0	1
Year	0	2	31	167	155	2	1	1	6

ST. HELENA. Lat. —15° 55′. Long. — 5° 43′. Height 40 ft. 5 Years, 1855–59. Hours $9\frac{1}{2}$: $3\frac{1}{2}$.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	1	15	10	1	0	0	0
Feb.	1	0	1	14	7	1	1	0	0
March	0	1	0	13	10	2	1	1	0
April	1	0	0	14	8	2	0	0	0
May	1	1	0	13	8	2	0	1	2
June	0	3	0	12	8	2	0	1	1
July	0	0	0	13	11	3	0	0	0
Aug.	1	1	1	14	8	2	1	1	1
Sept.	0	0	0	13	12	1	0	1	1
Oct.	0	0	0	15	9	3	0	0	1
Nov.	0	1	0	14	9	3	0	1	0
Dec.	1	1	0	13	10	2	0	0	0
Year	5	8	3	163	110	24	3	6	6

ST. THOMAS. Lat. 0° 20′. Long. 6° 43′. Height 16 ft. 9 Years, 1872–80. Hours 9 : 3, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	0	1	11	5	1	0	11
Feb.	2	0	1	0	12	3	1	0	9
March	3	1	1	2	12	3	1	1	7
April	2	1	1	2	11	4	1	1	7
May	1	0	1	1	17	4	1	0	6
June	1	0	0	1	21	5	1	0	1
July	1	0	0	1	21	5	1	0	2
Aug.	1	0	1	1	20	4	0	0	4
Sept.	1	0	0	1	18	4	1	0	5
Oct.	2	0	0	2	13	4	2	1	7
Nov.	2	0	1	1	13	3	2	0	8
Dec.	2	0	0	1	12	5	1	0	10
Year	20	2	6	14	181	49	13	3	77

SAN SALVADOR. Lat. —6° 17′. Long. 14° 53′. Height 1860 ft. 2 Years, 1885–86. Hours 9 : 3, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	1	4	8	7	2	6
Feb.	1	1	1	2	4	8	7	2	2
March	1	1	0	1	4	7	7	2	8
April	0	2	2	2	4	5	3	2	10
May	1	0	2	1	3	6	6	1	11
June	0	0	0	1	2	2	5	3	17
July	0	0	0	0	2	4	9	2	14
Aug.	0	1	0	1	1	6	8	2	12
Sept.	0	0	0	0	1	4	7	1	17
Oct.	1	0	0	1	1	2	5	2	19
Nov.	1	0	1	0	1	1	3	1	22
Dec.	0	0	1	2	1	1	3	1	22
Year	6	6	8	12	28	54	70	21	160

CHINCHOXO. Lat. —5° 9′. Long. 12° 3′. Height 39 ft. Hours 6 : 2, 10, and 7 : 2, 9. $2\frac{1}{3}$ Years, 1874–76.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	6	1	4	8	6	0	1
Feb.	1	4	7	0	4	5	6	1	0
March	1	3	5	2	5	8	5	0	2
April	0	4	5	2	4	8	6	1	0
May	1	3	6	2	6	7	4	1	1
June	1	2	6	2	7	8	2	1	1
July	1	3	6	1	4	8	6	1	1
Aug.	1	2	7	1	7	8	3	1	1
Sept.	0	1	5	2	9	8	2	0	3
Oct.	0	1	5	2	10	9	1	1	2
Nov.	1	3	6	2	5	8	3	1	1
Dec.	0	4	6	4	7	8	1	0	1
Year	8	34	70	21	72	93	45	8	14

VIVI. Lat. —4° 40′. Long. 13° 49′. Height 374 ft. $1\frac{1}{2}$ Years, 1882–83. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	1	0	16	5	1	5
Feb.	2	0	0	0	1	14	4	0	7
March	4	0	1	0	0	13	5	1	7
April	4	1	1	1	0	10	4	0	9
May	3	0	1	1	1	13	7	2	3
June	3	0	0	0	1	11	10	2	3
July	3	0	0	1	1	13	8	4	1
Aug.	4	0	0	0	1	14	10	1	1
Sept.	1	0	0	0	2	17	9	1	0
Oct.	1	0	0	1	1	18	9	0	1
Nov.	2	0	1	2	2	16	3	0	4
Dec.	1	1	1	1	1	13	5	0	8
Year	29	3	6	8	11	168	79	12	49

Month.	S. PAUL DE LOANDA. Lat. —8° 49′. Long. 13° 7′. Height 194 ft. 3 Years, 1879–81. Hours 9, N.: 3, 9.									GONDOKORO. Lat. 4° 55′. Long. 31° 28′. Height 1526 ft. 3–4 Years, 1853–54, 80. Hours various									TANGANIKA SEA. Lat. —4° 0′. Long. 29° 0′. Height 2460 ft. 1¾ Years, 1880–82. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	1	3	5	12	4	1	1	1	19	1	2	1	4	2	...	3	11	11	0	1	0	0	0	4
Feb.	2	1	1	1	2	3	14	3	1	1	1	5	2	11	3	5	0	...	1	3	9	0	0	0	0	1	5
March	2	1	1	1	3	4	14	4	1	1	2	7	2	11	5	3	0	...	7	4	0	1	0	2	4	1	12
April	2	1	1	1	4	3	11	4	3	1	2	7	1	13	1	3	2	...	7	1	1	0	2	2	2	0	15
May	3	1	1	0	4	4	11	3	4	2	3	3	1	18	1	3	0	...	5	1	1	0	4	0	10	0	10
June	2	1	1	1	3	4	10	4	4	0	1	0	2	23	1	1	2	...	2	1	2	0	6	1	10	0	8
July	3	1	1	1	3	4	8	4	6	11	1	1	2	10	0	2	4	...	0	1	1	0	10	1	10	0	8
Aug.	2	1	1	1	4	3	10	4	5	8	7	3	0	8	2	1	2	...	1	2	1	0	10	1	8	0	8
Sept.	2	0	0	1	3	3	12	4	5	8	5	8	0	6	0	2	1	...	5	2	0	1	8	0	7	0	7
Oct.	1	0	0	1	3	3	17	3	3	10	8	1	0	8	1	2	1	...	...	...	...	...	...	...	...	...	...
Nov.	2	0	1	0	2	4	15	4	2	10	10	3	1	4	0	2	0	...	...	...	...	...	...	...	...	...	...
Dec.	2	1	0	1	4	6	11	3	3	14	11	0	0	6	0	0	0	...	0	1	18	0	1	0	3	3	5
Year	26	9	9	10	38	46	145	44	38	67	52	57	12	120	15	28	14	...	...	...	...	...	...	...	...	...	...

Month.	KAKOMA AND IGONDA. Lat. —5° 40′. Long. 32° 35′. Height 3675 ft. 1 Year, 1881–82. Hour: 2.									RUBAGO. Lat. —5° 24′. Long. 33° 33′. Height 4265 ft. 1½ Years, 1880–81. Hours (?)									MOSING. Lat. —20° 58′. Long. 24° 28. Height (?) ft. 1 Year, 1873–74. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	11	5	0	0	2	6	0	7	9	1	1	7	8	2	1	1	1	0	0	2	0	0	10	9	10	0
Feb.	1	3	1	0	1	2	3	4	13	2	2	0	0	20	2	1	0	1	0	1	1	0	0	5	5	14	0
March	1	3	2	2	2	3	1	3	14	3	1	0	15	10	1	1	0	0	0	8	3	0	0	4	6	7	0
April	1	1	3	5	5	2	0	0	13	0	1	2	6	15	2	0	1	3	2	3	7	1	0	2	12	3	0
May	1	1	4	8	5	1	0	0	11	1	1	1	4	15	3	1	0	5	1	3	16	2	2	1	2	3	1
June	0	2	3	9	12	3	0	0	1	2	2	0	4	8	3	1	0	10	0	2	20	0	0	2	5	1	0
July	0	1	3	15	3	6	1	0	2	7	1	1	0	2	1	3	0	16	0	5	13	1	0	2	7	2	1
Aug.	0	1	4	12	2	4	0	1	7	6	2	2	2	1	1	0	1	16	0	3	11	3	0	3	8	0	0
Sept.	1	1	4	12	4	3	0	0	5	...	...	...	...	...	...	...	...	...	0	4	7	0	0	5	10	3	1
Oct.	1	1	2	20	2	1	0	0	4	...	...	...	...	...	...	...	...	...	0	5	9	3	0	5	7	1	1
Nov.	0	2	4	14	2	0	3	1	4	3	1	0	2	4	2	3	3	0	4	6	2	1	0	6	3	8	0
Dec.	1	1	3	2	4	1	6	4	9	0	5	2	0	4	10	4	4	2	0	1	2	0	0	3	10	10	2
Year	7	28	38	99	42	28	20	13	90	...	...	...	...	...	...	...	...	...	7	41	93	11	2	48	84	62	6

Month.	WALFISCHBAY. Lat. —22° 56′. Long. 14° 26′. Height 10 ft. 1 Year, 1885–86. Hours 7: 1, 9.									PORT NOLLOTH. Lat. —29° 15′. Long. 16° 52′. Height (?) ft. 5 Months, 1876–77. Hours 8: 8.									CAPE TOWN. Lat. —33° 56′. Long. 18° 27′. Height 37 ft. Hours various. 18 Years, 1842–55, 62–65.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	1	0	1	7	9	3	3	...	...	...	...	...	...	...	...	...	1	0	0	2	21	1	2	4	...
Feb.	6	0	0	0	2	5	10	2	3	...	...	...	...	...	...	...	...	...	1	0	0	2	18	1	2	4	...
March	4	0	1	0	5	8	7	2	4	...	...	...	...	...	...	...	...	...	1	0	1	2	17	1	3	6	...
April	1	1	2	0	10	9	1	1	5	...	...	...	...	...	...	...	...	...	2	0	0	3	14	2	3	6	...
May	1	1	4	2	4	9	4	0	6	...	...	...	...	...	...	...	...	...	3	0	0	2	13	1	3	9	...
June	0	1	4	0	8	9	4	1	3	...	...	...	...	...	...	...	...	...	5	0	0	1	9	3	4	8	...
July	1	3	4	0	4	7	4	0	8	...	...	...	...	...	...	...	...	...	5	0	0	1	12	2	4	7	...
Aug.	3	2	3	0	2	12	3	1	5	1	0	1	10	0	1	1	2	0	3	0	0	2	11	2	5	8	...
Sept.	8	1	1	0	1	8	3	2	6	0	0	2	16	0	2	1	5	0	2	0	0	2	12	2	5	7	...
Oct.	7	2	1	1	1	12	2	2	3	0	0	2	9	2	2	2	4	0	2	0	0	1	14	2	6	6	...
Nov.	8	1	2	0	0	8	3	1	7	0	0	1	2	0	1	1	1	0	2	0	0	2	17	1	3	5	...
Dec.	5	2	1	0	1	11	6	0	5	0	0	0	4	2	2	3	0	1	1	0	0	3	20	1	3	3	...
Year	49	16	24	3	39	105	56	15	58	...	...	...	...	...	...	...	...	...	28	0	1	23	178	19	43	73	...

Month.	CLANWILLIAM. Lat. —32° 10′. Long. 18° 53′. Height 300 ft. Year 1876–77. Hours 8 : 8.									KIMBERLEY. Lat. —28° 48′. Long. 25° 2′. Height 4060 ft. 2 Years, 1876, 82. Hours 8 : 8.									ALIWAL NORTH. Lat. —30° 43′. Long. 26° 43′. Height 4400 ft. 4 Years, 1876–77, 79–82. Hours 8 : 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	7	10	2	3	1	2	...	7	10	2	1	4	1	3	3	0	2	1	0	14	1	0	4	6	3
Feb.	1	3	2	9	6	1	2	4	...	5	9	6	0	1	1	2	3	1	1	2	0	12	0	0	1	6	6
March	2	2	6	3	5	2	1	10	...	6	10	7	2	2	2	1	1	0	1	3	1	12	0	1	0	2	11
April	1	2	1	5	5	2	3	11	...	5	4	6	1	7	2	1	2	2	1	1	1	11	0	0	1	4	11
May	1	1	1	3	6	1	3	15	...	4	4	7	1	8	2	2	1	2	1	1	0	7	0	1	0	4	17
June	2	1	6	6	7	0	0	8	...	8	7	3	2	6	1	2	1	0	1	1	0	6	0	0	0	6	16
July	1	1	5	9	3	7	1	4	...	6	5	11	1	3	1	2	1	1	1	1	0	5	0	1	0	6	17
Aug.	1	1	4	6	7	4	2	6	...	9	7	3	1	5	2	2	1	1	1	1	0	6	1	0	1	7	14
Sept.	...	...	...	...	...	...	...	...	...	10	5	3	2	4	2	2	2	0	·0	1	0	9	0	1	0	7	12
Oct.	0	5	8	5	6	3	1	3	...	6	3	3	1	5	4	4	3	2	1	1	0	10	1	1	1	9	7
Nov.	0	1	10	3	1	1	8	6	...	10	4	4	2	2	2	4	1	1	1	2	0	10	1	1	1	6	8
Dec.	2	2	3	8	4	2	3	7	...	11	4	2	1	4	4	3	1	1	2	2	1	11	2	1	1	7	4
Year	...	...	...	...	...	...	...	...	...	87	72	57	15	51	24	28	20	11	13	17	3	113	6	7	10	70	126

Month.	PORT ELIZABETH. Lat. —33° 57′. Long. 25° 37′. Height 181 ft. 4 Years, 1876–77, 79–82. Hours 8 : 8.									GRAHAM'S TOWN. Lat. —33° 20′. Long. 26° 33′. Height 1800 ft. $4\frac{1}{2}$ Years, 1854–59. Hours $9\frac{1}{2}$: $3\frac{1}{2}$.									FORT NAPIER. Lat. —29° 3′. Long. 30° 2′. Height 2300 ft. 15 Years, 1870–84. Hours 9 : 3.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	5	5	1	5	11	1	2	0	3	4	9	3	9	2	1	...	1	8	11	5	1	1	1	1	2
Feb.	0	1	5	4	1	3	9	2	3	1	2	2	8	3	7	2	3	...	1	6	11	5	1	1	0	1	2
March	1	1	3	5	1	4	10	2	4	1	3	2	8	3	8	1	5	...	1	6	10	6	1	1	0	1	5
April	1	3	4	2	2	2	9	3	4	1	2	2	4	2	9	3	7	...	1	6	10	5	1	0	1	1	5
May	2	7	4	2	1	5	5	4	1	1	1	1	2	1	8	3	14	..	1	5	11	5	1	1	1	1	5
June	2	7	2	2	0	2	8	4	3	1	1	0	1	1	6	5	15	...	1	5	9	5	2	1	1	1	5
July	2	8	3	3	0	2	6	4	3	1	1	0	1	1	7	6	14	...	1	5	10	5	2	1	1	1	5
Aug.	3	4	3	3	1	3	9	4	1	0	2	2	2	1	9	5	10	...	1	5	10	4	1	1	1	2	6
Sept.	2	2	4	4	1	3	10	3	1	1	3	3	3	2	9	4	5	...	1	6	10	4	2	0	1	2	4
Oct.	1	1	4	6	1	2	11	4	1	1	3	3	5	5	9	2	3	...	1	7	10	6	1	0	1	2	3
Nov.	1	2	3	5	1	5	10	2	1	0	2	4	8	4	7	3	2	...	1	6	9	6	1	1	1	2	3
Dec.	1	1	4	4	1	3	12	2	3	1	2	3	8	5	9	1	2	...	1	8	11	4	1	0	1	1	4
Year	16	38	44	45	11	39	110	35	27	9	25	26	59	31	97	37	81	...	12	73	122	60	15	8	10	16	49

Month.	PIETERMARITZBURG. Lat. —29° 30′. Long. 30° 2′. Height 2096 ft. 6 Years, 1860–65. Hours 9 : 3.									LOURENÇO MARQUES. Lat. —25° 28′. Long. 32° 37′. Height 16 ft. $1\frac{3}{4}$ Years, 1876–78. Hours 8, N.: 8.									TAMATAVE. Lat. 18° 3′. Long. 49° 11′. Height 0 ft. 3 Months, 1863. Hours 9 : 4.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	10	9	4	1	1	1	0	1	5	7	5	6	2	0	2	3	...	...	...	...	...	...	...	...	...
Feb.	2	3	8	10	3	1	0	1	0	2	2	5	5	5	2	0	3	4	...	...	...	...	...	...	...	...	...
March	2	2	10	9	4	2	1	0	1	1	3	4	8	7	2	0	3	3	...	...	...	...	...	...	...	...	...
April	2	3	7	8	4	3	2	1	0	4	3	5	4	5	1	0	1	7	...	...	...	...	...	...	...	...	...
May	1	2	8	6	5	5	3	1	0	6	4	4	3	3	2	1	3	5	...	...	...	...	...	...	...	...	...
June	1	2	7	5	5	5	4	1	0	3	2	5	5	3	2	0	3	7	...	...	...	...	...	...	...	...	...
July	2	2	7	5	6	5	3	1	0	1	2	6	7	4	1	0	1	9	...	...	...	...	...	...	...	...	...
Aug.	2	2	9	7	5	3	1	2	0	3	4	7	5	2	0	0	2	8	2	0	1	3	15	10	0	0	...
Sept.	2	3	7	8	4	3	1	2	0	4	3	3	6	8	1	0	2	3	2	2	0	2	10	8	2	4	...
Oct.	2	2	9	9	4	1	2	2	0	4	4	5	4	7	2	0	1	4	3	10	1	6	5	6	0	0	...
Nov.	2	2	9	9	5	1	0	2	0	4	5	5	5	6	2	0	1	2	...	...	...	...	..	...	...	...	...
Dec.	2	3	10	10	3	1	1	1	0	3	6	6	5	7	1	0	2	1	...	...	...	...	...	...	...	...	...
Year	22	29	101	95	52	31	20	15	1	36	43	62	62	63	18	1	24	56	...	...	...	...	...	...	...	...	...

Month.	REUNION. Lat. −20° 50′. Long. 52° 15′. Height 51 ft. 3 Years, 1883–85. Hours $9\frac{1}{3}$: $3\frac{1}{3}$.									MAURITIUS. Lat. −20° 6′. Long. 57° 33′. Height 30 ft. 6 Years, 1853–59. Hours $9\frac{1}{2}$: $3\frac{1}{2}$.									SOMERSET, CAPE YORK. Lat. −10° 44′. Long. 142° 36′. Height 70 ft. $2\frac{1}{3}$ Years, 1865–67. Hours 9 : 3, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	6	14	5	1	2	1	1	2	6	12	6	1	1	1	2	0	4	1	2	1	0	1	3	17	2
Feb.	0	1	5	16	3	1	1	0	1	1	3	7	9	0	1	2	5	0	2	2	4	2	1	2	3	8	4
March	0	1	4	15	7	1	2	1	0	1	4	11	9	1	1	1	3	0	1	1	10	7	1	1	1	6	3
April	0	0	5	14	6	1	1	1	2	1	4	12	9	0	1	1	2	0	1	1	10	14	1	1	1	1	0
May	0	0	4	16	8	1	1	1	0	1	2	9	13	2	1	1	2	0	0	0	13	17	1	0	0	0	0
June	1	0	4	16	4	1	2	1	1	1	1	9	12	3	1	1	1	1	0	0	10	17	2	1	0	0	0
July	0	0	4	16	7	2	2	0	0	1	0	9	16	2	0	1	1	1	0	0	6	22	2	1	0	0	0
Aug.	1	0	4	19	4	1	1	1	0	1	1	10	15	1	0	1	2	0	0	0	7	22	2	0	0	0	0
Sept.	0	0	5	18	6	0	1	0	0	1	2	9	12	2	0	2	2	0	0	0	11	16	1	1	0	1	0
Oct.	0	0	8	13	5	1	2	1	1	1	2	13	11	1	0	1	2	0	1	0	12	16	1	0	1	0	0
Nov.	1	0	5	16	5	0	1	1	1	2	4	11	5	1	1	2	4	0	1	3	17	7	0	0	0	2	0
Dec.	1	0	4	15	6	2	1	1	1	2	5	13	4	1	0	2	3	1	1	0	8	3	1	3	2	9	4
Year	4	3	58	188	66	12	17	9	8	15	34	125	121	15	7	16	29	3	11	8	110	144	13	11	11	44	13

Month.	SWEERS ISLAND. Lat. −15° 0′. Long. 136° 0′. Height 33 ft. $2\frac{1}{2}$ Years, 1868–71. Hours 9 : 3, 9.									BRISBANE. Lat. −27° 28′. Long. 153° 6′. Height 130 ft. 8 Years, 1867–75. Hours 9 : 3, 9.									SYDNEY. Lat. −33° 52′. Long. 151° 11′. Height 155 ft. 9 Years, 1867–75. Hourly.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	6	4	1	1	1	2	6	...	3	11	5	6	3	1	1	1	...	2	7	6	4	7	2	2	1	...
Feb.	9	4	1	3	2	2	2	5	...	1	8	3	8	5	2	0	1	...	2	5	5	4	7	2	2	1	...
March	5	6	4	6	3	3	2	2	...	1	7	4	8	7	2	1	1	...	3	6	5	5	5	3	2	2	...
April	2	7	1	17	0	1	1	1	...	1	4	3	5	9	6	2	0	...	4	3	2	2	3	4	7	5	...
May	0	0	5	17	6	2	0	1	...	1	1	1	3	9	10	4	2	...	3	1	1	2	3	3	11	7	...
June	4	4	5	8	6	1	1	1	...	1	2	1	3	8	9	5	1	...	3	2	1	1	1	3	12	7	...
July	1	2	5	13	8	0	1	1	...	1	2	1	3	7	10	5	2	...	2	1	1	1	2	4	13	7	...
Aug.	5	3	7	10	4	0	1	1	...	1	7	1	2	7	7	5	1	...	3	2	1	1	2	4	11	7	...
Sept.	10	5	3	2	4	2	2	2	...	2	6	2	3	6	5	4	2	...	3	4	3	2	3	3	7	5	...
Oct.	15	3	3	0	1	1	4	4	...	6	9	3	3	3	2	2	3	...	3	6	4	2	6	3	4	3	...
Nov.	12	3	2	2	1	1	3	6	...	5	10	3	4	3	2	1	2	...	2	6	5	3	6	3	3	2	...
Dec.	12	5	4	1	1	1	3	4	...	5	12	3	3	3	2	1	2	...	3	6	5	5	6	2	2	2	...
Year	85	48	44	80	37	15	22	34	...	28	79	30	51	70	58	31	18	...	33	49	39	32	51	36	76	49	...

Month.	WINDSOR. Lat. −33° 36′. Long. 150° 49′. Height 53 ft. 14 Years, 1863–76. Hours 9 : 3.									MELBOURNE. Lat. −37° 50′. Long. 144° 50′. Height 91 ft. 8 Years, (?) Hourly.									EUCLA. Lat. −31° 45′. Long. 128° 58′. Height 7 ft. 3 Years, 1880–82. Hours 9 : 3.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	6	3	9	2	4	2	2	2	2	1	1	6	11	6	2	2	0	1	1	7	10	7	3	1	1	0
Feb.	1	6	2	5	2	7	1	1	3	2	1	2	5	7	6	2	3	0	1	1	6	14	5	1	0	0	0
March	1	5	3	7	2	7	2	1	3	4	1	3	4	7	6	2	4	0	3	1	6	11	5	3	1	1	0
April	1	4	1	3	2	9	2	2	6	5	2	3	4	4	3	1	7	1	6	2	7	6	2	1	2	2	2
May	1	5	1	2	1	8	4	4	5	8	4	6	3	2	2	1	5	0	8	1	3	3	3	5	4	3	1
June	1	6	1	1	1	6	4	5	5	9	4	5	2	2	1	1	6	0	10	1	2	2	3	2	4	4	2
July	2	6	0	2	1	8	4	4	4	8	4	4	3	2	2	1	6	1	10	1	2	4	3	3	3	4	1
Aug.	2	5	2	2	2	6	5	4	3	7	4	4	4	3	1	1	7	0	8	2	3	3	2	5	4	2	2
Sept.	2	6	2	2	1	6	3	6	2	6	4	7	4	3	1	1	4	0	5	1	4	5	5	6	1	3	0
Oct.	1	8	3	4	2	5	2	3	3	4	3	5	6	6	2	1	3	1	3	1	6	8	5	4	3	1	0
Nov.	1	5	4	5	3	5	2	3	2	2	1	4	6	8	4	2	3	0	1	1	5	12	3	4	2	1	1
Dec.	1	7	3	8	3	4	1	3	1	2	1	4	7	9	4	2	2	0	2	1	5	13	5	3	0	1	1
Year	15	69	25	50	22	75	32	38	39	59	30	48	54	64	38	17	52	3	58	14	56	91	48	40	25	23	10

ADELAIDE. Lat. —34° 57′. Long. 138° 35′. Height 140 ft. Hours M, 3, 6, 9, N.: 3, 6, 9. 7 Years, 1876–82.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	3	5	9	7	3	1	...
Feb.	1	3	3	5	7	5	3	1	...
March	2	3	3	5	8	6	3	1	...
April	3	5	3	3	5	5	4	2	...
May	7	6	2	2	4	4	3	3	...
June	8	6	2	1	3	4	4	2	...
July	8	7	2	2	3	3	4	2	...
Aug.	7	7	1	1	2	4	5	4	...
Sept.	4	4	1	2	5	6	5	3	...
Oct.	3	4	2	2	5	8	5	2	...
Nov.	2	2	2	2	6	10	5	1	...
Dec.	1	2	3	3	7	10	4	1	...
Year	47	51	27	33	64	72	48	23	...

PORT DARWIN. Lat. —12° 28′. Long. 130° 51′. Height 70 ft. 3 Years, 1880–82. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	0	2	1	2	1	18	6
Feb.	0	1	1	2	0	1	0	17	6
March	0	2	0	1	1	0	3	14	10
April	0	1	0	13	1	0	1	5	9
May	0	2	0	22	0	0	0	2	5
June	0	0	0	25	1	0	0	1	3
July	1	0	0	24	1	0	0	1	4
Aug.	1	3	0	11	0	0	0	5	11
Sept.	3	1	0	9	1	0	1	6	9
Oct.	1	1	1	7	1	0	2	6	12
Nov.	3	1	0	5	1	1	2	12	5
Dec.	2	1	1	7	1	0	2	11	6
Year	12	13	3	128	9	4	12	98	86

ALICE SPRINGS. Lat. —23° 38′. Long. 133° 37′. Height 2100 ft. 3 Years, 1880–82. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	6	1	2	0	2	17
Feb.	0	1	1	17	0	1	0	1	8
March	0	1	1	16	1	0	0	1	11
April	0	1	0	15	1	1	0	1	11
May	1	1	1	13	0	1	1	2	11
June	0	0	0	15	0	0	1	1	13
July	0	0	1	16	0	0	0	2	12
Aug.	1	1	1	10	0	1	0	2	15
Sept.	0	1	1	14	0	1	0	3	10
Oct.	0	2	1	13	1	1	0	6	7
Nov.	1	2	2	11	1	0	0	2	11
Dec.	1	2	2	16	1	1	1	2	5
Year	5	13	12	162	5	9	3	25	131

FREEMANTLE. Lat. 33° 2′. Long. 115° 45′. Height 16 ft. 3 Years, 1853–55. Hours 9½ : 3½.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	5	5	7	5	8	0	1	...
Feb.	0	3	5	5	2	9	3	1	...
March	0	6	3	8	2	8	2	2	...
April	0	4	5	8	4	4	2	3	...
May	1	6	9	8	1	4	0	2	...
June	1	13	6	4	2	1	1	2	...
July	1	8	2	2	4	5	2	7	...
Aug.	1	8	3	2	1	5	4	7	...
Sept.	1	3	7	2	3	4	8	2	...
Oct.	1	4	3	3	7	4	6	3	...
Nov.	0	1	7	1	4	10	4	3	...
Dec.	0	1	5	2	4	12	5	2	...
Year	6	62	60	52	39	74	37	35	...

KENT'S GROUP. Lat. —39° 29′. Long. 147° 25′. Height 280 ft. 5 Years, 1861–66. Hours 6, N.: 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	5	4	1	1	7	10	1	...
Feb.	2	4	5	1	0	6	9	1	...
March	3	5	5	1	1	6	8	2	...
April	4	4	3	2	1	4	9	3	...
May	4	3	2	1	1	5	10	5	...
June	2	4	4	2	1	4	9	4	...
July	3	2	2	3	2	4	11	4	...
Aug.	3	4	2	2	1	6	9	4	...
Sept.	3	3	2	0	1	4	14	3	...
Oct.	3	3	4	2	1	4	12	2	...
Nov.	3	3	3	1	0	5	13	2	...
Dec.	2	4	3	1	1	5	13	2	...
Year	34	44	39	17	11	60	127	33	...

HOBART TOWN. Lat. —42° 52′. Long. 147° 21. Height 37 ft. 5½ Years, 1861–67. Hours 6, N.: 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	2	7	2	4	3	7	...
Feb.	3	2	1	8	2	3	2	7	...
March	4	1	2	7	3	2	2	10	...
April	3	2	1	5	2	4	2	11	...
May	4	2	1	2	2	4	2	14	...
June	4	1	1	1	1	3	4	15	...
July	5	1	1	2	2	3	3	14	...
Aug.	4	2	1	3	2	4	2	13	...
Sept.	4	2	1	3	2	3	3	12	...
Oct.	4	2	1	6	2	4	2	10	...
Nov.	3	3	1	6	1	3	3	10	...
Dec.	3	2	3	9	2	2	2	8	...
Year	45	22	16	59	23	39	30	131	...

PORT ARTHUR. Lat. —43° 9′. Long. 147° 54′. Height 55 ft. 5 Years, 1861–66. Hours 6, N.: 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	6	1	8	2	6	3	4	...
Feb.	1	4	2	7	2	5	3	4	...
March	1	5	1	7	2	5	2	8	...
April	1	4	0	5	2	8	2	8	...
May	2	2	0	3	2	7	3	12	...
June	2	3	1	1	2	6	6	9	...
July	0	1	1	2	1	6	6	14	...
Aug.	4	2	1	2	2	8	5	7	...
Sept.	4	3	0	3	3	6	5	6	...
Oct.	2	5	1	6	3	6	4	4	...
Nov.	2	3	1	5	3	5	5	6	...
Dec.	1	6	2	10	2	5	2	3	...
Year	21	44	11	59	26	73	46	85	...

AUCKLAND. Lat. —36° 50′. Long. 174° 51′. Height 258 ft. Hours 9½ : 3½. 8 Years, 1853–59, 1866–67.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	2	2	4	9	3	2	...
Feb.	3	6	1	2	3	8	2	3	...
March	3	6	3	4	3	7	2	3	...
April	2	4	2	4	3	10	2	3	...
May	1	3	1	3	4	10	4	5	...
June	1	4	3	4	4	7	4	3	...
July	2	5	3	4	5	7	2	3	...
Aug.	1	5	3	4	3	9	2	4	...
Sept.	2	6	2	2	2	5	4	7	...
Oct.	2	4	1	1	3	10	6	4	...
Nov.	2	3	2	0	3	10	6	4	...
Dec.	5	6	1	1	4	7	4	3	...
Year	26	59	24	31	41	99	41	44	...

SOUTHLAND. Lat. —46° 17′. Long. 168° 20′. Height 79 ft. Hours 9 : 3, 7. 8 Years, 1858–66, 1866–67.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	3	9	0	1	8	9	...
Feb.	1	0	2	8	0	0	10	7	...
March	1	0	2	6	0	1	11	10	...
April	1	0	2	4	1	0	11	11	...
May	1	0	4	2	0	0	9	15	...
June	2	0	5	2	0	1	8	12	...
July	2	1	7	4	0	0	5	12	...
Aug.	1	0	4	3	0	1	10	12	...
Sept.	2	0	6	6	1	1	6	8	...
Oct.	1	0	2	9	0	1	9	9	...
Nov.	1	0	3	8	1	1	8	8	...
Dec.	1	0	3	9	1	1	9	7	...
Year	15	1	43	70	4	8	104	120	...

AUCKLAND ISLAND. Lat. —50° 32′. Long. 166° 5′. Height 10 ft. 5 Months, 1874–75. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	3	1	1	1	14	5	2
Feb.	1	1	1	0	0	1	18	4	2
March	...	...	...	...	...	...	...	...	...
April	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	0	0	1	1	1	2	15	5	6
Nov.	1	2	2	0	0	1	14	7	3
Dec.	3	4	5	3	1	1	7	5	2
Year	...	...	...	...	...	...	...	...	...

CHATHAM. Lat. —43° 52′. Long. 176° 42′. Height 100 ft. 2 Years, 1880-81. Hour 9½:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	1	2	1	12	5	3	...
Feb.	6	1	1	4	1	8	1	6	...
March	5	2	7	6	2	3	3	3	...
April	5	1	1	2	3	13	2	3	...
May	5	2	2	3	3	9	3	4	...
June	2	2	5	8	2	9	1	1	...
July	2	2	6	4	1	9	2	5	...
Aug.	3	1	2	6	1	8	1	9	...
Sept.	4	2	0	0	2	9	2	11	...
Oct.	5	2	1	6	2	6	3	6	...
Nov.	4	2	2	1	2	12	2	5	...
Dec.	5	1	3	4	1	5	5	7	...
Year	51	20	31	46	21	103	30	63	...

HATZFELDTHAFEN. Lat. —4° 24′. Long. 145° 14′. Height 7 ft. 7 Months, 1886–87. Hours 7: 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	4	2	7	4	2	1	8
Feb.	0	1	1	0	1	5	12	1	7
March	2	6	2	1	2	1	2	1	14
April	1	4	3	2	2	2	1	2	13
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	2	7	1	1	1	0	0	0	7
Nov.	2	7	8	2	1	0	0	0	10
Dec.	1	5	1	1	4	2	6	1	11
Year	...	...	...	...	...	...	...	...	...

APIA, NAVIGATOR ISLANDS. Lat. —13° 50′. Long. —171° 44′. Height 0 ft. 1½ Years, 1862-65. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	5	13	1	1	1	3	4	...
Feb.	3	3	17	1	2	0	0	2	...
March	6	3	11	2	1	1	3	4	...
April	1	2	13	4	4	1	2	3	...
May	4	2	17	5	3	0	0	0	...
June	1	1	15	9	4	0	0	0	...
July	1	3	17	6	0	1	0	3	...
Aug.	0	5	19	3	2	1	0	1	...
Sept.	0	8	16	5	0	0	0	1	...
Oct.	0	5	20	4	2	0	0	0	...
Nov.	3	4	16	5	0	1	0	1	...
Dec.	2	5	18	2	1	0	1	2	...
Year	24	46	192	47	20	6	9	21	...

SUVA. Lat. —18° 8′. Long. 178° 26′. Height 10 ft. 2 Years, 1886-87. Hour 9:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	9	6	7	0	3	1	0	0
Feb.	6	8	5	3	0	1	1	1	3
March	6	7	5	6	2	2	2	0	1
April	3	11	12	1	0	1	0	1	1
May	5	4	4	9	2	2	1	2	2
June	5	8	5	5	1	1	0	3	2
July	1	10	7	6	0	5	0	0	2
Aug.	2	5	6	12	2	2	1	0	1
Sept.	4	11	5	7	1	1	1	0	0
Oct.	3	6	6	13	1	1	0	1	0
Nov.	3	9	6	8	2	1	0	1	0
Dec.	3	5	8	10	2	2	0	1	0
Year	46	93	75	87	13	22	7	10	12

TAHITI. Lat. —17° 32′. Long. —149° 34′. Height Sea Level. 3 Years, 1858–60. Hours 4 times daily.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	9	6	1	0	0	6	3	2
Feb.	4	7	10	1	0	0	4	5	0
March	0	6	8	2	1	2	6	6	0
April	1	5	9	0	0	2	8	4	1
May	3	7	6	1	0	0	3	8	3
June	1	5	7	5	2	2	2	4	2
July	1	4	8	5	3	5	2	1	2
Aug.	0	2	8	2	5	8	3	2	1
Sept.	1	3	7	3	7	6	2	1	0
Oct.	2	8	8	4	1	4	1	2	1
Nov.	5	4	6	2	0	0	5	8	0
Dec.	2	7	4	0	0	1	4	12	1
Year	21	67	87	26	19	30	46	56	13

TONGATABU. Lat. —21° 10′. Long. —174° 50′. Height 0 ft. 3 Years, 1872–74. Hours 4, 8, N.: etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	12	2	2	2	1	0	2	0
Feb.	7	8	3	2	3	1	1	3	0
March	4	8	9	3	2	1	2	2	0
April	7	7	5	2	3	1	1	4	0
May	7	9	7	4	2	0	1	1	0
June	1	5	4	9	6	1	1	3	0
July	6	3	10	4	5	1	1	1	0
Aug.	4	4	4	4	9	0	1	1	4
Sept.	6	1	11	5	5	2	0	0	0
Oct.	4	7	13	4	1	0	0	2	0
Nov.	1	12	11	2	2	0	0	0	2
Dec.	6	12	7	4	1	0	1	0	0
Year	63	88	86	45	41	8	9	19	6

HONOLULU. Lat. 21° 18′. Long. —157° 50′. Height 0 ft. Hours S.-R.: 2. 6 Years, 1837–38, and 1869–72.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	15	0	1	7	1	1	0	3
Feb.	2	17	1	0	6	1	0	0	1
March	0	20	0	1	5	1	0	0	4
April	1	25	1	1	2	0	0	0	0
May	1	28	0	0	2	0	0	0	0
June	0	26	1	0	2	0	0	0	1
July	0	28	1	0	1	0	0	0	1
Aug.	0	28	0	0	2	0	0	0	1
Sept.	0	29	1	0	0	0	0	0	0
Oct.	1	18	2	1	7	0	0	0	2
Nov.	1	18	1	1	6	1	0	2	0
Dec.	1	17	0	0	10	1	1	0	1
Year	10	269	8	5	50	5	2	2	14

HONOLULU. Lat. 21° 18′. Long. —157° 50′. Height 52 ft. 2½ Years, 1885–87. Hours 10: 4.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	11	0	3	4	6	3	1	...
Feb.	1	16	1	1	3	4	2	0	...
March	2	16	1	2	4	4	2	0	...
April	1	21	2	1	3	2	0	0	...
May	1	26	1	1	1	1	0	0	...
June	1	28	0	0	1	0	0	0	...
July	1	29	1	0	0	0	0	0	...
Aug.	0	27	1	1	2	0	0	0	...
Sept.	2	26	1	1	0	0	0	0	...
Oct.	3	21	1	1	2	2	1	0	...
Nov.	1	21	0	1	3	2	1	1	...
Dec.	4	16	1	0	5	3	1	1	...
Year	20	258	10	12	28	24	10	3	...

EAST OF NOVA ZEMBLA. Lat. 70° 37′. Long. 57° 0′. Height 0 ft. 3½ Years, 1832–35 (irreg). Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	5	1	3	5	2	3	2	3
Feb.	3	2	6	2	4	2	5	1	3
March	8	3	4	1	3	2	3	2	5
April	9	8	2	1	2	2	2	1	3
May	8	3	2	3	1	4	4	2	4
June	6	3	3	3	3	4	4	2	2
July	4	4	2	1	3	7	5	3	2
Aug.	6	3	1	2	3	3	6	3	4
Sept.	4	1	5	1	2	2	7	4	4
Oct.	4	2	3	5	6	4	4	2	1
Nov.	6	3	7	1	3	1	6	2	1
Dec.	4	2	7	3	6	4	1	1	3
Year	69	39	43	26	41	37	50	25	35

KARMAKULI. Lat. 72° 23′. Long. 52° 42′. Height 23 ft. 1 Year, 1882–83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	7	8	3	2	0	1	6
Feb.	1	0	3	6	9	3	1	2	3
March	2	2	9	10	3	1	0	1	3
April	3	1	3	7	8	3	0	2	3
May	4	1	6	7	3	1	0	4	5
June	5	0	2	2	2	4	2	10	3
July	2	2	6	3	1	2	2	6	7
Aug.	3	2	6	3	2	3	1	5	6
Sept.	5	2	3	7	3	1	0	4	5
Oct.	3	2	5	9	5	3	1	3	0
Nov.	2	2	6	7	4	3	1	1	4
Dec.	3	4	3	5	6	4	0	1	5
Year	35	20	59	74	49	30	8	40	50

BEAR ISLAND. Lat. 74° 52′. Long. 19° 57′. Height 0 ft. 1 Year, 1865–66. Hours 8: 2, 8.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	11	12	4	2	1	0	0	0
Feb.	0	4	12	6	4	1	0	1	0
March	4	9	11	1	1	2	1	1	1
April	3	5	6	1	3	2	3	5	2
May	4	7	9	3	1	1	2	2	2
June	1	2	4	4	2	2	2	2	2
July	...	...	...	...	...	...	...	...	...
Aug.	7	4	1	1	2	1	4	3	4
Sept.	6	2	1	2	5	4	2	6	2
Oct.	3	12	7	2	1	2	2	2	0
Nov.	2	3	2	3	4	5	5	6	0
Dec.	1	11	12	4	2	1	0	0	0
Year	...	...	...	...	...	...	...	...	...

JAN MAYEN. Lat. 70° 59′. Long. —8° 28′. Height 35 ft. 1 Year, 1882–83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	7	8	1	1	1	3	2
Feb.	2	2	8	10	2	0	1	3	0
March	8	1	3	4	2	1	2	8	2
April	5	4	6	8	1	1	2	3	0
May	8	6	2	5	2	0	1	6	1
June	4	1	3	11	4	1	0	5	1
July	6	3	1	12	1	0	1	6	1
Aug.	8	2	2	7	1	1	1	3	6
Sept.	4	1	7	7	3	1	1	6	0
Oct.	4	0	10	11	1	0	1	3	1
Nov.	6	2	6	10	1	0	1	3	1
Dec.	11	2	5	6	1	0	1	4	1
Year	72	25	65	99	19	6	13	53	16

SABINE ISLAND. Lat. 74° 32′. Long. —18° 49′. Height 0 ft. 1 Year, 1869–70. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	1	2	0	1	1	3	2	14
Feb.	9	0	1	1	3	2	3	2	7
March	14	0	1	0	2	1	4	1	8
April	12	0	0	1	3	2	2	3	7
May	5	1	3	2	7	1	3	1	8
June	7	2	4	2	3	1	1	1	9
July	3	1	3	3	4	2	1	1	13
Aug.	4	2	0	2	5	2	4	3	9
Sept.	11	1	1	0	1	2	1	3	10
Oct.	8	1	2	1	2	1	3	6	7
Nov.	14	0	1	0	1	0	4	4	6
Dec.	14	0	1	1	4	0	4	3	4
Year	108	9	19	13	36	15	33	30	102

VAN RENSSELLER. Lat. 78° 37′. Long. —70° 53′. Height 0 ft. 1½ Years, 1853–54. Hourly.

Month.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	0	4	3	3	1	1	1	0	18
Feb.	1	5	3	3	0	1	0	0	15
March	0	3	5	1	1	1	0	0	20
April	0	3	6	4	0	2	2	0	13
May	0	2	3	4	0	6	3	0	13
June	0	0	0	2	1	7	1	0	19
July	0	1	1	2	1	3	1	0	22
Aug.	0	3	3	0	1	3	1	0	20
Sept.	1	2	2	4	1	1	1	1	17
Oct.	1	5	5	4	1	1	0	0	14
Nov.	1	3	2	2	1	1	1	0	19
Dec.	1	5	2	2	1	1	0	0	19
Year	5	36	35	31	9	28	11	1	209

UPERNAVIK. Lat. 72° 47′. Long. —55° 53′. Height 39 ft. 12 Years, 1874–85. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E	S.	S.W	W.	N.W	CA.
Jan.	3	1	11	1	1	4	0	0	10
Feb.	3	2	11	0	1	3	0	0	8
March	2	2	9	1	1	7	1	0	8
April	4	2	7	1	1	4	0	0	11
May	6	2	5	1	1	4	0	1	11
June	7	1	3	1	1	5	1	1	10
July	7	1	2	1	0	5	1	1	13
Aug.	7	2	3	1	1	6	1	1	9
Sept.	4	2	5	2	1	4	1	1	10
Oct.	3	1	14	2	1	4	1	1	4
Nov.	3	2	14	1	1	3	1	1	4
Dec.	3	2	13	1	1	3	1	1	6
Year	52	20	97	13	11	52	8	8	104

JACOBSHAVEN. Lat. 69° 19′. Long. —50° 55′. Height 41 ft. 12 Years, 1874–85. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	10	3	3	2	0	0	11
Feb.	1	1	7	2	4	2	0	0	11
March	1	1	5	3	4	3	0	1	13
April	4	1	3	3	4	2	1	1	11
May	5	1	4	2	2	2	1	1	13
June	5	1	2	2	2	3	3	1	11
July	3	1	2	2	2	2	2	2	15
Aug.	3	0	4	3	2	2	2	2	13
Sept.	3	1	6	3	2	2	1	1	11
Oct.	2	1	14	3	2	1	0	0	8
Nov.	1	1	14	3	2	1	0	0	8
Dec.	1	1	13	3	3	2	0	0	8
Year	30	11	84	32	32	24	10	9	133

GODTHAAB. Lat. 64° 11′. Long. —56° 26′. Height 37 ft. 12 Years, 1874–85. Hours 8: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	9	4	1	3	2	1	3	3
Feb.	6	7	3	1	3	1	1	4	2
March	6	7	3	1	5	2	1	3	3
April	5	7	3	1	4	2	1	2	5
May	5	7	2	0	6	3	1	2	5
June	4	5	1	0	6	4	2	3	5
July	2	4	1	0	8	5	2	3	6
Aug.	3	5	1	1	9	4	1	2	5
Sept.	2	7	3	0	8	2	1	1	6
Oct.	3	8	5	1	6	2	1	1	4
Nov.	3	9	5	1	6	1	0	1	4
Dec.	4	9	5	1	4	1	1	2	4
Year	48	84	36	8	68	29	13	27	52

Month.	FREDERIKSHAAB. Lat. 62° 0′. Long. —49° 24′. Height 0 ft. 4 Years, 1856–60. Hour, N.									IVIGTUT. Lat. 61° 12′. Long. —48° 11′. Height 16 ft. 6 Years, 1880–85. Hours 8: 2, 9.									HOFFENTHAL. Lat. 55° 27′. Long. —60° 12′. Height 25 ft. 3 Years, 1882–84. Hours 8: 2, 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	7	2	3	1	4	0	1	5	2	4	1	5	1	1	0	2	15	3	0	1	0	1	5	13	6	2
Feb.	6	6	2	3	0	4	1	1	5	2	4	0	4	1	1	1	2	13	2	0	1	0	2	3	14	6	0
March	7	5	2	4	1	5	1	1	5	2	3	0	5	2	1	1	3	14	11	1	1	1	1	3	9	3	1
April	8	2	1	4	1	6	0	0	8	2	1	0	5	1	2	1	3	15	14	2	1	0	1	2	4	4	2
May	15	1	0	1	1	5	0	0	8	2	0	0	4	1	2	3	5	14	14	2	0	2	2	3	4	3	1
June	12	0	0	0	1	9	2	2	4	2	0	0	3	2	2	4	8	9	6	2	2	1	3	4	6	4	2
July	12	0	0	2	1	7	1	1	7	3	0	0	1	1	2	2	7	15	9	7	3	2	2	2	2	2	2
Aug.	14	0	0	1	3	5	0	2	6	3	0	0	3	1	1	2	5	16	9	4	3	1	2	3	3	4	2
Sept.	12	1	0	3	1	10	0	3	0	4	1	0	4	1	1	1	4	14	7	2	2	0	3	3	8	5	0
Oct.	13	0	0	2	1	8	0	1	6	4	1	0	5	1	0	1	2	17	6	1	1	1	2	5	9	6	0
Nov.	5	4	1	5	1	7	0	0	7	3	2	0	4	1	1	0	2	17	7	2	1	0	1	3	10	5	1
Dec.	9	8	1	4	1	3	0	0	5	2	6	0	4	1	1	1	2	14	9	0	1	0	1	4	11	4	1
Year	121	34	9	32	13	73	5	12	66	31	22	1	47	14	15	17	45	173	97	23	17	8	21	40	93	52	14

Month.	ZOAR. Lat. 56° 7′. Long. —61° 22′. Height 31 ft. 3 Years, 1882–84. Hours 8: 2, 8.									NAIN. Lat. 56° 33′. Long. —61° 41′. Height 14 ft. 3 Years, 1882–84. Hours 8: 2, 8.									OKAK. Lat. 57° 34′. Long. —61° 56′. Height 25 ft. 3 Years, 1882–84. Hours 8: 2, 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	0	1	0	0	1	8	15	2	1	1	1	0	1	2	15	5	5	2	0	1	0	0	3	20	3	2
Feb.	2	0	0	1	0	1	8	13	3	1	1	0	1	0	3	15	6	1	1	0	0	0	0	2	22	2	1
March	4	1	4	2	0	1	6	9	4	3	4	2	2	1	5	8	5	1	3	3	2	1	1	4	13	2	2
April	2	4	3	2	0	1	5	7	6	4	6	2	1	1	2	7	5	2	5	4	1	0	2	3	11	2	2
May	4	4	5	2	2	1	4	5	4	3	8	4	1	1	2	5	2	5	5	5	3	1	2	2	7	2	4
June	2	3	3	2	1	1	5	10	3	2	3	3	1	1	4	8	6	2	3	5	2	0	5	5	9	1	0
July	2	5	8	2	2	2	3	2	5	2	8	8	2	1	3	3	2	2	5	10	3	0	4	4	1	1	3
Aug.	3	5	4	3	1	1	6	5	3	3	6	6	1	1	3	4	4	3	4	7	4	0	4	4	3	1	4
Sept.	3	2	2	1	2	2	8	8	2	3	2	3	1	2	3	8	7	1	2	4	3	0	2	6	7	1	5
Oct.	3	2	1	1	1	2	9	10	2	4	2	2	1	1	2	11	6	2	2	3	2	0	1	5	14	2	2
Nov.	3	2	2	1	0	1	7	12	2	4	2	1	0	1	3	11	6	2	3	2	1	0	1	2	15	3	3
Dec.	8	2	1	0	0	1	4	13	2	4	1	1	0	1	2	10	6	6	3	2	1	0	0	4	18	2	1
Year	40	30	34	17	9	15	73	109	38	34	44	33	11	12	34	105	60	32	38	45	23	2	22	44	140	22	29

Month.	HEBRON. Lat. 58° 12′. Long. —62° 21′. Height 49 ft. 3 Years, 1882–81. Hours 8: 2, 8.									KINGUA-FIORD. Lat. 66° 36′. Long. —66° 56′. Height 53 ft. 1 Year, 1882–83. Hourly.									ASSISTANCE BAY. Lat. 74° 40′. Long. —94° 16′. Height 0 ft. 1 Year, 1850–51. 4-hourly.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	0	1	0	5	15	3	2	4	1	0	0	2	2	1	3	18	13	1	0	0	1	1	2	11	2
Feb.	1	1	0	0	1	6	15	1	3	3	2	0	1	2	2	1	2	15	12	5	1	1	1	1	0	5	2
March	3	2	1	1	2	6	8	1	7	3	4	1	4	4	2	0	0	13	10	5	2	2	1	0	1	6	4
April	8	2	1	1	1	4	4	5	4	3	3	1	2	4	2	1	1	13	5	3	3	6	5	1	0	5	2
May	9	3	0	1	2	2	3	3	8	3	2	1	2	9	8	0	1	5	5	1	1	5	3	3	4	8	1
June	4	5	2	0	3	3	7	3	3	1	2	0	3	9	10	1	0	4	4	4	0	0	0	10	9	3	0
July	11	6	2	1	2	2	4	1	2	1	2	0	3	8	13	1	0	3	1	0	2	7	5	6	5	3	2
Aug.	9	6	1	1	3	2	4	3	2	1	1	0	2	12	10	2	0	3	4	3	3	2	4	7	1	6	1
Sept.	6	4	1	1	1	3	6	5	3	4	3	1	2	7	5	1	2	5	2	4	4	2	3	3	5	4	3
Oct.	6	1	1	1	2	3	9	7	1	9	9	1	1	1	2	1	2	5	9	3	2	3	2	1	4	6	1
Nov.	3	2	1	0	1	5	11	5	2	4	4	2	3	4	3	1	1	8	7	4	4	5	1	2	1	4	2
Dec.	3	2	1	0	1	6	11	2	5	3	3	0	1	2	3	1	2	16	10	4	1	0	3	1	1	9	2
Year	66	36	11	8	19	47	97	39	42	39	36	7	24	64	62	11	14	108	82	37	23	33	29	36	33	70	22

REPULSE BAY. Lat. 66° 32′. Long. —86° 55′. Height 0 ft. Hours thrice daily. 3 Years, 1846–47, 1853–54.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	12	0	1	1	0	0	2	13	2
Feb.	8	0	0	1	1	1	4	9	4
March	15	1	0	1	1	0	2	9	2
April	9	2	1	5	2	0	3	5	3
May	10	2	4	1	1	1	4	5	3
June	7	2	3	4	1	1	2	6	4
July	9	3	3	2	0	1	3	5	5
Aug.	...	...	...	...	...	...	...	...	...
Sept.	6	1	3	3	1	1	3	7	5
Oct.	7	2	2	2	2	1	0	12	3
Nov.	7	1	2	2	1	0	2	12	3
Dec.	16	1	1	0	1	1	1	7	3
Year	...	...	...	...	...	...	...	...	...

PORT KENNEDY. Lat. 72° 1′. Long. —94° 14′. Height 0 ft. 1 Year, 1858–59. 4-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	0	0	0	0	2	19	4
Feb.	0	3	1	0	0	0	7	13	4
March	0	9	1	1	0	0	2	8	10
April	4	11	4	0	0	0	3	3	5
May	5	4	1	0	0	0	9	7	5
June	2	7	2	0	0	1	2	12	4
July	1	6	2	1	0	2	4	11	4
Aug.	0	10	2	0	0	1	9	6	3
Sept.	5	6	1	2	2	3	7	3	1
Oct.	2	9	2	2	1	1	3	10	1
Nov.	1	7	2	0	0	0	1	16	3
Dec.	0	4	2	0	0	1	3	16	5
Year	22	80	20	6	3	9	52	124	49

OOGLAAMIE. Lat. 71° 23′. Long. —156° 40′. Height 17 ft. 2 Years, 1881–83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	7	2	1	3	6	3	1
Feb.	3	2	2	2	3	7	6	2	1
March	1	3	4	5	4	5	7	2	0
April	3	2	4	5	3	3	6	3	1
May	3	9	7	3	2	4	2	1	0
June	6	8	7	3	0	2	2	2	0
July	4	6	8	3	2	4	3	1	0
Aug.	3	6	9	4	2	3	2	2	0
Sept.	3	5	8	3	3	3	2	3	0
Oct.	2	10	10	3	3	1	0	2	0
Nov.	1	10	9	3	2	1	1	3	0
Dec.	3	6	5	4	3	2	4	2	2
Year	36	71	80	40	28	38	41	26	5

FORT CONFIDENCE. Lat. 66° 40′. Long. —119° 0′. Height (?) ft. Hours 18 times daily. 7 Months, 1848–49.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	8	2	1	3	5	3	3
Feb.	1	3	7	1	1	2	6	3	4
March	1	4	11	4	0	1	6	0	4
April	1	2	9	5	0	1	10	2	0
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	2	11	9	6	0	0	1	0	2
Nov.	2	9	10	5	0	0	2	1	1
Dec.	1	6	16	2	1	1	1	0	3
Year	...	...	...	...	...	...	...	...	...

FORT CONFIDENCE. Lat. 66° 40′. Long. —119° 0′. Height (?) ft. Oct. 1850—June 1851. Hours 9 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	8	2	2	1	3	3	8
Feb.	2	2	7	2	1	2	3	2	7
March	0	4	14	4	0	1	2	1	5
April	3	2	4	5	2	1	2	4	7
May	3	5	6	6	2	2	2	2	3
June	0	0	1	2	1	0	1	1	1
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	2	4	13	7	1	1	0	1	2
Nov.	1	4	12	4	2	0	3	1	3
Dec.	1	6	12	1	1	0	2	1	7
Year	...	...	...	...	...	...	...	...	...

FORT GARRY. Lat. 49° 51′. Long. —97° 7′. Height 754 ft. $6\frac{1}{2}$ Years, 1881–87. Hour $5\frac{1}{2}$:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	1	0	2	6	3	2	6	2
Feb.	7	2	1	3	5	3	2	5	0
March	8	3	1	2	5	3	2	4	3
April	7	2	3	5	4	3	1	3	2
May	7	3	4	3	6	2	3	3	0
June	5	2	2	4	6	4	2	4	1
July	4	2	2	3	6	3	3	7	1
Aug.	5	3	2	3	5	5	2	4	2
Sept.	4	2	3	4	3	4	4	6	0
Oct.	5	3	2	4	5	4	3	5	0
Nov.	8	2	1	3	5	2	3	5	1
Dec.	5	2	1	3	5	3	2	8	2
Year	74	27	22	39	61	39	29	60	14

QU' APPELLE. Lat. 50° 44′. Long. —103° 42′. Height 2115 ft. 4 Years, 1883–87. Hour 5 :

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	0	3	5	3	8	9
Feb.	0	1	2	2	3	5	1	6	8
March	1	4	2	2	4	5	2	6	5
April	2	4	1	2	7	2	1	3	8
May	3	3	2	3	4	4	3	4	5
June	1	2	3	3	6	4	2	4	5
July	1	1	2	2	5	5	3	4	8
Aug.	2	1	2	2	6	2	3	3	10
Sept.	1	1	1	1	6	4	6	4	6
Oct.	1	1	2	3	5	6	2	4	7
Nov.	1	1	1	2	5	6	3	5	6
Dec.	0	1	1	1	2	5	5	7	9
Year	14	21	20	23	56	53	34	58	86

MEDICINE HAT. Lat. 50° 1′. Long. —110° 37′. Height 2136 ft. 4 Years, 1883–87. Hour $4\frac{1}{2}$:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	1	4	6	2	2	11
Feb.	2	3	1	1	3	3	2	3	10
March	1	2	4	2	6	4	3	1	8
April	2	3	4	2	4	2	2	2	9
May	2	1	7	1	4	2	5	2	7
June	2	2	3	2	2	4	3	1	11
July	2	2	4	4	3	3	4	3	6
Aug.	3	1	2	2	2	5	3	2	11
Sept.	3	1	1	1	3	5	2	4	10
Oct.	1	2	1	1	4	4	2	2	14
Nov.	2	1	0	1	3	3	4	2	14
Dec.	3	2	0	0	5	4	4	2	11
Year	26	21	28	18	43	45	36	26	122

MINNEDOSA. Lat. 50° 13′. Long. —99° 48′. Height 1665 ft. 4 Years, 1883–87. Hour $5\frac{1}{2}$:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	2	2	2	1	4	10	3
Feb.	3	4	3	1	1	0	5	8	3
March	2	3	4	1	1	1	4	6	9
April	5	5	3	2	1	2	3	3	6
May	4	4	4	2	1	2	4	5	5
June	2	6	4	2	1	3	2	3	7
July	2	4	5	3	1	1	5	6	4
Aug.	2	3	5	2	1	1	3	4	10
Sept.	1	2	5	2	1	2	4	6	7
Oct.	2	4	5	2	1	2	3	8	4
Nov.	2	3	4	3	1	1	4	9	3
Dec.	2	2	2	2	0	1	5	11	6
Year	32	42	46	24	12	17	46	79	67

SWIFT CURRENT. Lat. 50° 21′. Long. —107° 33′. Height 2439 ft. 2 Years, 1885–86. Hour 5 :

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	2	3	4	4	6	3	8
Feb.	1	2	2	5	7	2	5	0	4
March	1	1	5	3	3	5	9	0	4
April	3	1	4	2	5	5	3	0	7
May	2	2	2	5	7	4	5	0	4
June	2	3	4	3	3	3	5	3	4
July	1	0	2	5	5	3	3	2	10
Aug.	1	4	1	2	6	4	3	2	8
Sept.	0	0	1	2	10	3	5	5	4
Oct.	1	0	2	1	16	6	0	2	3
Nov.	2	2	0	0	7	7	6	4	2
Dec.	1	2	0	2	7	4	8	3	4
Year	16	17	25	33	80	50	58	24	62

FORT RAE. Lat. 62° 39′. Long. —115° 44′. Height 530 ft. 1 Year, 1882–83. Hours 9 : 3.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	0	4	4	0	0	0	7	9
Feb.	7	1	2	2	0	0	3	8	5
March	5	0	6	7	1	0	1	5	6
April	5	1	8	10	1	0	0	4	1
May	5	0	7	11	2	0	1	5	0
June	6	3	7	6	2	1	1	4	0
July	4	2	6	8	3	1	2	4	1
Aug.	4	2	7	5	3	1	2	5	2
Sept.	7	3	6	6	1	0	2	5	0
Oct.	4	2	6	6	4	2	1	5	1
Nov.	5	3	3	4	2	2	1	5	5
Dec.	6	1	3	3	2	1	1	6	8
Year	65	18	65	72	21	8	15	63	38

IKOGMET. Lat. 61° 47′. Long. —161° 14′. Height 75 ft. Hours 8, N. : 4, M. 2 Years, 1843, 48–50, 53–54.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	2	1	1	1	2	3	15
Feb.	3	9	3	1	1	3	1	3	4
March	4	4	3	2	0	2	4	3	9
April	2	6	4	1	0	1	0	4	12
May	1	5	5	1	1	3	1	1	13
June	2	2	1	3	1	4	3	3	11
July	4	8	3	0	0	4	5	4	3
Aug.	1	3	3	0	9	7	0	4	4
Sept.	1	7	6	3	1	0	1	2	9
Oct.	1	3	6	1	.1	1	1	3	14
Nov.	2	5	1	2	0	1	2	2	15
Dec.	2	4	3	2	1	3	1	2	13
Year	24	61	40	17	16	30	21	34	122

FORT WRANGEL. Lat. 56° 16′. Long. —132° 20′. Height 30 ft. $3\frac{3}{4}$ Years, 1869–76. Hours 7 : 2, 9.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	9	9	2	2	0	1	4	1
Feb.	3	12	5	4	0	1	0	3	0
March	3	8	9	4	4	0	1	2	0
April	1	4	6	7	5	1	3	2	1
May	1	3	8	6	4	1	2	2	4
June	1	3	2	3	3	2	4	3	9
July	1	1	3	6	3	1	7	4	5
Aug.	0	2	3	5	5	2	5	2	7
Sept.	2	1	7	6	3	1	4	3	3
Oct.	3	6	4	4	3	1	2	6	2
Nov.	4	7	4	1	5	1	1	3	4
Dec.	6	7	5	4	4	1	1	2	1
Year	28	63	65	52	41	12	31	36	37

SITKA. Lat. 57° 3′. Long. —135° 19′. Height 15 ft. Hours various. 30 Years, 1833–34, 55–64, 67–76.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	6	4	2	1	2	1	5
Feb.	3	5	7	3	2	2	2	1	3
March	3	4	7	3	2	2	2	2	6
April	3	4	5	4	3	3	2	2	4
May	2	2	5	4	5	4	3	3	3
June	1	1	4	3	5	5	5	3	3
July	1	1	2	2	5	6	5	3	6
Aug.	1	1	3	3	4	5	4	3	7
Sept.	2	1	5	4	4	3	3	2	6
Oct.	2	2	8	7	3	2	2	1	4
Nov.	3	4	8	5	2	2	2	1	3
Dec.	4	5	8	4	2	1	2	2	3
Year	30	35	68	46	39	36	34	24	53

TONGASS. Lat. 54° 46′. Long. —130° 30′. Height 30 ft. 2 Years, 1868–70. Hours 7 : 2, 9.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	9	4	6	4	1	0	0	3
Feb.	3	6	5	6	4	1	1	0	2
March	6	5	5	6	5	1	0	1	2
April	4	1	4	7	8	1	2	0	3
May	3	3	4	5	7	1	3	1	4
June	2	3	1	5	12	2	1	1	3
July	1	0	0	9	13	2	1	3	2
Aug.	1	1	1	7	16	2	1	1	1
Sept.	4	1	4	4	12	1	1	3	0
Oct.	5	4	3	9	6	2	0	1	1
Nov.	4	6	6	6	5	1	0	1	1
Dec.	7	3	4	6	5	1	0	3	2
Year	44	42	41	76	97	16	10	15	24

FORT ALEXANDER. Lat. 58° 57′. Long. —158° 18′. Height 18 ft. 5 Months, 1886. Hour $1\frac{1}{2}$:

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	13	13	0	4	1	0	0	...
Feb.	1	7	17	0	1	0	1	1	...
March	0	6	10	2	3	3	5	2	...
April	0	9	10	1	1	7	2	0	...
May	1	5	3	6	6	7	2	1	...
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

UNALASCHKA. Lat. 53° 52′. Long. —166° 31′. Height 10 ft. 7 Years, 1825–34. Hours thrice daily.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	3	4	4	1	3	3	6
Feb.	3	1	4	3	4	2	2	3	6
March	4	1	2	4	4	3	4	5	4
April	3	1	3	4	4	4	4	3	4
May	2	2	4	4	3	3	4	4	5
June	2	2	3	4	5	4	2	2	6
July	1	1	1	4	5	7	4	1	7
Aug.	2	1	1	3	4	4	5	3	8
Sept.	3	1	1	3	3	4	6	3	6
Oct.	2	1	1	3	3	5	4	5	7
Nov.	3	1	2	3	3	3	6	3	6
Dec.	7	1	2	2	2	3	3	5	6
Year	38	14	27	41	44	43	47	40	71

ST. MICHAEL'S. Lat. 63° 48′. Long. —161° 48′. Height 30 ft. Hours 7 : 3, 11. 10 Years, 1874–78, 81–86.

Month	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	10	4	2	5	3	1	0	1
Feb.	6	7	2	1	4	2	1	1	4
March	8	8	3	2	2	4	1	0	3
April	6	6	4	1	4	4	1	1	3
May	7	6	3	1	4	4	2	2	2
June	5	5	2	2	4	5	3	2	2
July	5	5	3	2	7	5	2	1	1
Aug.	5	3	3	2	7	6	2	2	1
Sept.	6	5	4	3	5	3	2	2	0
Oct.	6	7	5	3	5	2	2	1	0
Nov.	6	7	3	2	5	3	2	1	1
Dec.	4	8	4	2	4	4	1	0	4
Year	69	77	40	23	56	45	20	13	22

CAMDEN BAY. Lat. 70° 8′. Long. —145° 29′. Height 0 ft. 1 Year, 1853–54. Hours 4, 8, N.: etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	3	1	1	2	14	3	7
Feb.	0	2	2	0	0	1	13	2	8
March	1	3	5	0	0	1	13	3	5
April	1	3	9	1	0	1	9	2	4
May	1	2	18	1	0	0	3	2	4
June	2	7	14	1	0	0	2	1	3
July	1	3	9	3	1	2	6	3	3
Aug.	...	...	...	...	...	...	...	...	...
Sept.	0	1	18	0	1	3	4	1	2
Oct.	2	8	4	1	1	2	8	3	2
Nov.	0	1	7	2	1	1	12	3	3
Dec.	0	3	11	1	1	0	5	2	8
Year	...	...	...	...	...	...	...	...	...

ST. PAUL, KADIAK IS. Lat. 57° 47′. Long. —152° 20′. Height 20 ft. Hours thrice daily. 2¼ Years, 1869–70, 72–73.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	5	1	2	0	3	4	8	1
Feb.	6	1	0	3	2	4	3	7	2
March	4	5	0	1	0	5	5	8	3
April	3	7	5	4	2	2	2	4	1
May	3	10	5	5	2	1	2	2	1
June	1	8	6	8	3	2	1	0	1
July	2	3	4	4	2	7	3	2	4
Aug.	3	6	4	3	2	4	4	2	3
Sept.	3	5	5	7	3	2	1	3	1
Oct.	6	2	2	8	2	2	5	4	0
Nov.	3	2	2	6	5	4	3	4	1
Dec.	2	4	2	4	3	2	4	8	2
Year	43	58	36	55	26	38	37	52	20

ST. PAUL IS., PRIBILOFF IS. Lat. 57° 7′. Long. —170° 18′. Height 57 ft. 3 Years, 1869–71, 73–75. Thrice daily.

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	6	6	3	4	2	2	3	1
Feb.	4	5	3	2	4	3	2	5	0
March	7	4	3	2	3	3	3	6	0
April	6	5	6	4	2	1	1	5	0
May	7	5	4	3	3	3	2	3	1
June	3	5	2	3	4	3	4	5	1
July	3	2	3	3	5	6	4	3	2
Aug.	6	3	7	3	7	1	2	2	0
Sept.	8	6	4	4	0	1	3	4	0
Oct.	5	3	4	1	4	1	6	6	1
Nov.	5	5	4	4	2	3	3	4	0
Dec.	4	5	2	4	4	4	3	5	0
Year	62	54	48	36	42	31	35	51	6

MELVILLE SOUND. Lat. 74° 42′. Long. —101° 22′. Height 0 ft. ¾ Year, 1853–54. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	0	1	3	1	1	5	13	4
Feb.	3	1	1	1	5	0	2	13	2
March	7	3	2	4	2	1	3	8	1
April	1	2	2	7	3	4	4	5	2
May	4	2	3	0	1	0	4	14	3
June	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	4	1	3	1	3	5	4	8	1
Oct.	6	1	1	3	1	3	6	7	3
Nov.	9	1	1	1	1	1	4	8	4
Dec.	7	2	1	3	1	2	2	8	5
Year	...	...	...	...	...	...	...	...	...

DEALY ISLAND. Lat. 74° 56′. Long. —108° 48′. Height 0 ft. 1 Year, 1852–53. Hours 3, 9 : 3, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	3	5	1	0	2	3	4	3
Feb.	14	2	4	2	1	1	0	2	2
March	10	2	5	6	1	1	1	2	3
April	12	3	3	2	1	0	0	5	4
May	10	1	1	6	3	0	2	6	2
June	11	3	0	1	1	2	2	9	1
July	6	1	3	4	3	4	3	3	4
Aug.	9	2	1	2	1	3	5	4	4
Sept.	9	1	3	3	3	1	4	4	2
Oct.	13	3	1	2	2	2	2	3	3
Nov.	10	7	6	3	1	0	1	1	1
Dec.	17	2	2	3	1	0	1	3	2
Year	131	30	34	35	18	16	24	46	31

PRINCESS ROYAL ISLANDS. Lat. 72° 47′. Long. —117° 35′. Height 0 ft. 1 Year, 1850–51. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	1	0	1	5	5	8	7
Feb.	1	4	1	0	0	10	3	4	5
March	0	9	0	1	1	9	4	3	4
April	1	7	1	1	2	3	3	9	3
May	0	3	1	1	2	8	1	12	3
June	0	11	1	4	0	9	2	2	1
July	1	11	1	0	2	8	4	3	1
Aug.	2	4	3	3	1	6	6	4	2
Sept.	2	2	3	3	1	6	3	7	3
Oct.	2	11	4	0	2	2	2	1	7
Nov.	1	10	2	2	0	5	2	1	7
Dec.	0	5	1	0	1	6	4	9	5
Year	11	80	19	15	13	77	39	63	48

BEECHEY ISLAND. Lat. 74° 43′. Long. —91° 54′. Height 0 ft. 2 Years, 1852–54. Hours 4, 8, N.: etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	2	4	1	1	1	9	7
Feb.	4	1	2	6	3	0	0	6	6
March	1	1	4	7	2	0	2	8	6
April	2	1	3	5	2	1	2	7	7
May	3	1	2	3	2	1	2	11	6
June	4	2	2	4	2	1	4	6	5
July	2	2	4	6	3	1	2	5	6
Aug.	2	2	3	5	3	2	4	8	2
Sept.	3	3	3	4	2	2	3	7	3
Oct.	5	3	2	4	2	1	3	5	6
Nov.	4	2	2	6	4	1	0	6	5
Dec.	4	2	2	5	1	0	1	6	10
Year	39	21	31	59	27	11	24	84	69

MERCY BAY. Lat. 74° 6′. Long. —117° 55′. Height 0 ft. 1¾ Years, 1851–53. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	0	2	4	12	0	7	2
Feb.	4	3	0	2	3	5	0	6	5
March	4	2	0	2	5	8	0	5	5
April	7	2	1	4	5	5	1	1	4
May	5	3	0	3	1	5	1	9	4
June	4	4	1	2	1	6	1	9	2
July	5	1	0	1	2	2	1	15	4
Aug.	8	2	0	1	1	1	2	8	8
Sept.	8	1	0	0	2	4	5	5	5
Oct.	4	2	1	6	3	5	1	5	4
Nov.	4	2	1	3	2	4	1	6	7
Dec.	5	0	0	2	6	6	2	8	2
Year	61	23	4	28	35	63	15	84	52

CAMBRIDGE BAY. Lat. 69° 3′. Long. —105° 12′. Height 0 ft. 1 Year, 1852–53. Hours 4, 8, N.: etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	1	0	3	9	3	8
Feb.	3	4	2	2	0	1	2	8	6
March	1	5	3	6	1	0	4	5	6
April	4	7	5	1	1	1	1	8	2
May	3	3	2	5	3	1	4	7	3
June	7	6	1	3	1	2	4	6	0
July	3	5	2	2	2	5	7	4	1
Aug.	3	2	1	3	2	3	8	5	4
Sept.	2	1	1	2	1	2	8	10	2
Oct.	4	10	3	2	1	2	1	4	4
Nov.	1	5	3	7	1	2	3	5	3
Dec.	2	7	1	2	1	1	6	7	4
Year	35	59	25	36	14	23	57	73	43

IGLOOLIK. Lat. 69° 21′. Long. —81° 53′. Height 0 ft. 1 Year, 1822–23. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	2	2	2	2	1	2	11	0
Feb.	7	2	1	0	0	0	3	14	1
March	8	1	0	0	0	2	7	13	0
April	8	0	0	1	1	2	5	13	0
May	5	3	1	5	4	3	4	6	0
June	10	2	1	1	2	3	3	8	0
July	4	2	2	11	2	0	2	5	3
Aug.	3	3	3	2	1	2	6	9	2
Sept.	2	2	3	5	1	0	6	11	0
Oct.	4	6	5	4	3	0	0	8	1
Nov.	4	0	1	1	1	2	8	12	1
Dec.	4	3	1	0	1	1	11	10	0
Year	68	26	20	32	18	16	57	120	8

WINTER ISLAND. Lat. 66° 11′. Long. —83° 10′. Height 0 ft. 1 Year, 1821–22. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	2	2	0	0	0	6	14	0
Feb.	9	1	0	0	0	1	1	16	0
March	7	2	1	0	0	3	5	13	0
April	5	3	3	3	1	4	3	6	2
May	7	5	1	1	0	2	4	10	1
June	4	2	4	5	1	3	3	6	2
July	5	4	2	3	5	0	2	8	2
Aug.	3	2	1	2	4	5	7	6	1
Sept.	3	3	4	4	5	2	3	5	1
Oct.	12	5	3	3	0	2	1	5	0
Nov.	9	5	2	1	1	2	4	6	0
Dec.	8	0	1	5	1	0	1	15	0
Year	79	34	24	27	18	24	40	110	9

MELVILLE ISLAND. Lat. 74° 47′. Long. —110° 48′. Height 0 ft. 1 Year, 1819–20. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	13	1	3	2	0	0	1	6	5
Feb.	12	1	1	1	1	0	2	7	3
March	18	1	1	1	1	0	3	5	1
April	11	1	3	2	0	0	0	5	8
May	11	1	1	1	4	0	0	8	5
June	7	1	2	3	4	1	6	4	2
July	10	2	0	2	5	2	3	4	3
Aug.	2	0	3	1	1	2	10	6	6
Sept.	11	4	0	0	0	5	4	5	1
Oct.	12	0	1	1	1	3	5	7	1
Nov.	18	0	0	1	0	1	1	6	3
Dec.	6	1	6	4	2	1	2	8	1
Year	131	13	21	19	19	15	37	71	39

FORT CONGER. Lat. 81° 20′. Long. —64° 58′. Height 24 ft. 2 Years, 1881–83. Hour 8:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	0	0	1	0	0	0	29
Feb.	0	3	3	0	1	0	0	1	20
March	1	4	5	2	2	1	1	1	14
April	3	5	8	6	1	0	0	1	6
May	3	5	7	4	4	2	2	2	2
June	1	2	3	4	7	6	4	2	1
July	0	1	1	5	6	11	6	1	0
Aug.	2	0	2	9	2	12	1	2	1
Sept.	5	7	6	2	2	2	0	1	5
Oct.	2	4	5	3	0	1	1	0	15
Nov.	1	3	6	2	0	1	0	0	17
Dec.	1	1	4	1	0	0	0	0	24
Year	19	36	50	38	26	36	15	11	134

WOLSTENHOLM SOUND. Lat. 76° 34′. Long. —68° 45′. Height 0 ft. 1 Year, 1849–50. Hours 4, 8, N.: etc.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	6	5	3	2	1	1	10
Feb.	2	2	6	3	2	4	1	1	7
March	1	2	10	3	3	4	3	0	5
April	2	2	8	1	1	4	2	2	8
May	0	2	6	1	3	6	5	2	6
June	6	2	6	1	3	4	1	2	5
July	6	2	4	1	1	3	2	8	4
Aug.	2	3	9	10	2	1	1	2	1
Sept.	2	4	7	8	2	1	2	2	2
Oct.	1	2	3	4	4	6	2	2	7
Nov.	1	1	4	2	2	2	1	1	16
Dec.	3	2	5	5	3	2	1	1	9
Year	27	26	74	44	29	39	22	24	80

PORT LEOPOLD. Lat. 73° 50′. Long. —90° 12′. Height 0 ft. 1 Year, 1848–49. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	1	0	4	5	0	1	9	2
Feb.	7	1	0	4	4	1	1	8	2
March	7	2	3	4	7	0	0	5	3
April	10	4	1	3	4	0	0	6	2
May	7	3	3	4	5	0	1	5	3
June	7	3	5	5	4	1	0	4	1
July	11	3	1	2	1	0	1	11	1
Aug.	7	1	2	5	4	2	2	6	2
Sept.	4	12	4	2	1	2	1	2	2
Oct.	7	2	3	4	2	1	2	8	2
Nov.	10	2	0	2	3	0	0	12	1
Dec.	8	3	0	3	6	1	1	7	2
Year	94	37	22	42	46	8	10	83	23

PORT BOWEN. Lat. 73° 13′. Long. —88° 55′. Height 0 ft. 1 Year, 1824–25. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	14	6	0	0	0	3	3
Feb.	3	3	15	3	0	0	1	2	1
March	1	0	18	0	0	2	2	7	1
April	2	0	12	8	0	0	4	3	1
May	3	2	8	3	2	2	2	8	1
June	1	1	10	5	2	4	3	4	0
July	4	1	0	5	2	3	12	4	0
Aug.	7	10	1	0	1	4	1	7	0
Sept.	2	2	3	9	0	4	6	4	0
Oct.	3	4	7	9	1	1	2	4	0
Nov.	2	0	6	10	0	2	2	5	3
Dec.	5	1	9	10	0	2	0	2	2
Year	36	26	103	68	8	24	35	53	12

WALKER BAY. Lat. 71° 35′. Long. —117° 39′. Height 0 ft. 1 Year, 1851–52. 2-hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA
Jan.	2	4	3	2	1	1	2	4	12
Feb.	2	3	3	1	1	1	3	4	10
March	1	4	3	1	1	0	2	3	16
April	1	10	7	1	1	1	1	2	6
May	3	8	5	1	1	0	2	1	10
June	2	2	2	3	1	2	5	5	8
July	3	3	1	1	1	1	6	5	10
Aug.	3	3	5	3	1	2	4	3	7
Sept.	9	5	6	1	1	0	1	3	4
Oct.	6	9	7	1	1	1	1	1	4
Nov.	1	5	10	3	0	0	0	1	10
Dec.	3	3	4	2	3	2	1	4	9
Year	36	59	56	20	13	11	28	36	106

FORT SIMPSON. Lat. 62° 7′. Long. —121° 33′. Height 400 ft. 9 Months, 1849–50–51. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	2	3	1	0	7	9	8
Feb.	1	0	4	5	1	1	3	5	8
March	2	0	3	4	1	0	3	7	11
April	2	1	6	5	1	0	2	4	9
May	4	1	4	5	1	1	2	4	9
June	3	0	3	2	4	2	2	5	9
July	...	...	...	...	...	...	...	...	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	...	...	...	...	...	...	...	...	...
Oct.	2	0	3	6	1	1	5	5	8
Nov.	1	1	2	6	2	1	5	3	9
Dec.	1	0	3	4	2	1	5	4	11
Year	...	...	...	...	...	...	...	...	...

Month.	POINT LEPREAUX. Lat. 45° 4′. Long. —66° 28′. Height 46 ft. 6 Years, 1874-78, 80. Hours 7: 2, 9.									ANTICOSTI. Lat. 49° 24′. Long. —63° 36′. Height 20 ft. Hours thrice daily. 8 Years, 1872-78, 80.									NEWFOUNDLAND. Lat. 47° 35′. Long. —52° 42′. Height 13 ft. Hours 9: 3. 15 Years, 1853-62, 66, 70.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	5	1	3	2	3	2	12	...	2	1	4	2	1	1	1	19	...	4	2	1	1	2	4	9	6	2
Feb.	3	4	2	2	2	3	2	10	...	3	1	1	4	2	1	1	15	...	3	2	1	2	2	5	8	4	1
March	3	5	2	3	2	4	2	10	...	2	2	6	2	1	1	1	16	...	5	2	1	2	3	7	7	3	1
April	3	6	5	3	2	6	1	4	...	3	3	6	4	0	1	1	12	...	5	2	1	3	3	5	7	3	1
May	2	6	4	5	2	6	2	4	...	2	3	7	4	1	0	1	13	...	4	4	3	3	4	3	7	2	1
June	0	2	4	5	3	10	2	4	...	2	1	10	5	1	0	1	10	...	3	3	1	4	3	7	6	2	1
July	1	3	3	4	5	8	2	5	...	1	1	5	8	2	1	1	12	...	2	3	1	3	2	9	9	2	0
Aug.	1	3	4	5	3	6	2	7	...	2	2	7	4	1	1	2	12	...	3	2	2	3	3	7	8	2	1
Sept.	2	3	4	4	2	7	2	6	...	1	1	8	3	1	2	3	11	...	3	3	2	2	3	5	7	5	0
Oct.	3	4	2	7	2	4	2	7	...	2	1	5	4	2	1	1	15	...	4	3	1	2	3	6	7	4	1
Nov.	4	6	0	3	1	4	2	10	...	3	2	3	3	2	2	2	13	...	5	3	2	1	2	6	6	4	1
Dec.	4	5	0	3	1	3	2	13	...	3	1	1	2	3	2	1	18	...	4	2	1	2	2	5	9	5	1
Year	29	52	31	47	27	64	23	92	...	26	19	63	45	17	13	16	166	...	45	31	17	28	32	69	90	42	11

Month.	NORWAY HOUSE. Lat. 53° 43′. Long. —98° 30′. Height (?) ft. 7 Years, 1841-47. Hour (?)									YORK FACTORY. Lat. 57° 2′. Long. —92° 26′. Height 55 ft. 6 Years, 1843-48. Hours 9: 3, 9.									FORT CHURCHILL. Lat. 58° 44′. Long. —94° 22′. Height (?) ft. 3 Years, 1811-13. Hours 8, N.: 8.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	1	3	4	3	3	7	3	6	1	2	1	6	5	2	3	5	1	0	0	1	1	2	8	17	1
Feb.	5	5	1	2	5	2	1	4	3	6	1	2	1	4	1	2	4	7	1	0	0	1	2	1	11	11	1
March	8	4	1	2	6	2	1	4	3	10	2	1	1	4	2	1	2	8	2	1	1	1	1	1	13	10	1
April	4	7	1	2	6	2	0	5	3	6	4	3	1	4	1	1	1	9	3	2	3	2	3	1	6	9	1
May	4	6	1	1	9	2	0	3	5	7	6	2	1	3	0	0	2	10	5	4	5	2	4	1	3	5	2
June	4	4	1	1	8	3	0	2	7	3	6	4	1	4	0	1	1	10	6	6	3	2	3	1	2	6	1
July	5	3	1	1	8	2	1	5	5	3	6	6	1	4	0	0	1	10	5	7	6	5	2	0	3	3	0
Aug.	3	2	1	1	7	3	2	7	5	3	5	4	1	3	1	1	1	12	5	3	4	2	4	3	3	4	3
Sept.	5	2	0	3	5	2	3	6	4	4	2	2	1	5	0	2	3	11	5	2	3	2	2	2	6	7	1
Oct.	7	3	2	2	4	2	1	7	3	6	1	3	1	6	1	2	4	7	3	2	1	2	1	1	8	13	0
Nov.	7	3	2	2	6	1	2	4	3	4	1	3	1	8	3	4	3	3	4	1	2	2	2	2	5	11	1
Dec.	4	4	1	2	7	2	2	5	4	3	1	4	1	9	4	5	2	2	2	1	3	3	4	1	5	10	2
Year	59	47	13	22	75	26	16	59	48	61	36	36	12	60	18	21	27	94	42	29	31	25	29	16	73	106	14

Month.	RED RIVER SETTLEMENT. Lat. 50° 6′. Long. —97° 0′. Height 853 ft. 4 Years, 1855-59. Hours 7: 2, 9.									PORTLAND, ME. Lat. 43° 39′. Long. —70° 15′. Height 45 ft. 12 Years, 1873-84. Hours 7: 3, 11.*									BRUNSWICK, MAINE. Lat. 43° 53′. Long. —69° 55. Height (?) ft. Hours A.M., N.: P.M. 50 Years, 1809-59.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	1	0	10	4	3	3	3	7	2	0	1	1	4	6	7	3	2	7	1	1	1	6	2	11	...
Feb.	4	0	2	0	5	2	4	5	6	4	2	1	1	2	4	5	7	2	2	5	1	1	0	6	2	11	...
March	8	0	1	1	11	1	1	3	5	5	3	1	2	3	4	4	7	2	1	4	1	2	1	8	2	12	...
April	8	2	1	2	8	1	1	3	4	4	4	2	2	3	3	4	6	2	1	4	1	3	1	9	1	10	...
May	7	1	1	1	11	3	1	2	4	3	3	3	3	6	4	3	4	2	1	4	2	4	1	11	1	7	...
June	7	2	1	1	7	2	2	3	5	2	2	2	4	6	5	4	3	2	1	2	1	4	1	12	1	8	...
July	5	1	2	1	10	3	3	2	4	1	2	2	3	6	7	4	4	2	1	2	1	2	2	14	2	7	...
Aug.	5	1	2	1	7	3	4	3	5	3	2	2	3	5	6	3	4	3	1	2	1	3	1	14	2	7	...
Sept.	8	0	1	3	8	3	4	2	1	3	3	2	3	5	5	3	3	3	1	3	1	2	1	12	1	9	...
Oct.	6	1	1	1	11	3	4	3	1	5	2	2	2	3	5	5	5	2	1	4	1	2	1	9	2	11	...
Nov.	4	1	1	1	8	4	3	5	3	5	2	1	1	2	5	5	6	3	2	3	1	2	1	7	2	12	...
Dec.	6	1	1	1	9	3	3	2	5	5	2	1	1	1	5	7	6	3	2	7	1	1	0	6	2	12	...
Year	74	11	15	13	105	32	33	36	46	47	29	19	26	43	57	53	62	29	16	47	13	27	11	114	20	117	...

* Washington Mean Time.

NEW BEDFORD, MASS. Lat. 41° 39′. Long. —70° 56′. Height 90 ft. 16 Years, 1818–33. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	3	2	2	5	2	12	...
Feb.	2	2	2	2	2	5	3	10	...
March	2	3	3	3	2	6	3	9	...
April	1	4	4	3	2	7	3	6	...
May	1	3	2	4	3	9	4	5	...
June	1	2	2	3	3	10	5	4	...
July	1	2	2	3	3	11	5	4	...
Aug.	1	3	3	3	3	9	5	4	...
Sept.	1	3	3	3	3	8	4	5	...
Oct.	2	3	3	2	2	8	4	7	...
Nov.	2	2	3	2	2	6	3	10	...
Dec.	2	3	2	2	2	6	3	11	...
Year	18	33	32	32	29	90	44	87	...

MOUNT WASHINGTON, N.H. Lat. 44° 16′. Long. —71° 18′. Height 6279 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	0	1	1	3	4	19	0
Feb.	1	2	0	1	0	2	4	18	0
March	2	1	1	2	1	2	4	17	1
April	3	3	1	1	1	2	4	14	1
May	2	2	1	1	2	2	4	16	1
June	2	1	1	1	2	3	4	15	1
July	2	1	1	1	1	2	4	18	1
Aug.	2	2	1	1	1	2	3	18	1
Sept.	2	2	1	1	1	2	3	17	1
Oct.	2	1	1	1	1	3	4	17	1
Nov.	2	1	1	2	1	2	4	17	0
Dec.	2	1	1	1	1	2	4	19	0
Year	24	18	10	14	13	27	46	205	8

NEW YORK CITY, N.Y. Lat. 40° 43′. Long. —74° 0′. Height 164 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	5	1	1	2	4	8	7	1
Feb.	2	4	1	1	2	4	6	7	1
March	2	4	2	2	2	4	6	8	1
April	2	5	2	3	2	3	5	7	1
May	2	4	2	4	4	5	4	5	1
June	1	3	2	4	5	6	3	5	1
July	2	3	1	3	5	7	4	5	1
Aug.	2	5	2	3	4	7	3	4	1
Sept.	3	5	3	3	3	5	3	4	1
Oct.	2	4	2	2	3	6	5	6	1
Nov.	2	3	1	2	2	5	7	7	1
Dec.	2	4	1	1	2	5	8	7	1
Year	24	49	20	29	36	61	62	72	12

WASHINGTON, D.C. Lat. 38° 54′. Long. —77° 2′. Height 106 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	2	1	5	2	2	8	3
Feb.	3	3	1	1	5	2	2	8	3
March	4	3	2	2	5	1	3	9	2
April	3	4	2	2	5	2	2	9	1
May	4	3	2	2	8	2	2	6	2
June	3	2	2	2	7	4	3	5	2
July	4	2	1	2	7	4	3	5	3
Aug.	4	4	2	2	6	3	2	4	4
Sept.	4	4	2	1	6	2	2	5	4
Oct.	4	3	1	1	7	2	3	6	4
Nov.	3	3	2	1	6	2	3	7	3
Dec.	4	3	1	1	6	2	3	8	3
Year	44	38	20	18	73	28	30	80	34

ERIE, PA. Lat. 42° 7′. Long. —80° 05′. Height 681 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	3	1	2	7	8	5	3	1
Feb.	1	3	1	2	6	5	5	3	2
March	2	4	1	2	5	5	6	4	2
April	2	6	1	2	4	4	6	3	2
May	1	6	1	2	5	5	6	3	2
June	2	4	1	3	6	5	5	2	2
July	2	4	1	2	5	6	6	3	2
Aug.	3	3	2	4	7	3	5	2	2
Sept.	3	4	2	3	8	3	3	3	1
Oct.	2	3	1	3	9	4	4	4	1
Nov.	2	2	1	2	8	6	4	4	1
Dec.	2	2	1	2	7	8	4	4	1
Year	23	44	14	29	77	62	59	38	19

NORFOLK, VA. Lat. 36° 51′. Long. —76° 17′. Height 30 ft. 13 Years, 1872–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	5	2	2	4	4	3	4	1
Feb.	5	5	2	2	4	4	2	3	1
March	4	4	3	3	5	4	3	4	1
April	4	5	3	3	4	5	2	3	1
May	3	6	3	4	5	6	1	2	1
June	2	3	3	3	6	8	2	2	1
July	3	3	2	4	6	9	2	1	1
Aug.	2	5	3	4	5	7	1	2	2
Sept.	4	6	4	4	3	4	1	2	2
Oct.	5	6	2	3	5	4	1	3	2
Nov.	6	5	2	2	4	5	2	3	1
Dec.	5	5	2	1	3	6	3	4	2
Year	49	58	31	35	54	66	23	33	16

CAPE HATTERAS, N.C. Lat. 35° 14′. Long. —75° 30′. Height 8 ft. 11 Years, 1874–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	11	1	2	1	5	3	4	1
Feb.	2	11	1	2	2	4	3	2	1
March	3	11	2	2	2	5	3	2	1
April	2	10	2	3	3	6	2	2	0
May	2	10	2	3	3	7	2	1	1
June	0	7	2	4	3	10	2	1	1
July	1	6	2	3	4	11	2	1	1
Aug.	2	8	2	3	4	8	2	1	1
Sept.	2	13	2	3	2	4	2	1	1
Oct.	4	13	2	2	1	4	2	2	1
Nov.	5	10	1	2	1	4	3	3	1
Dec.	5	9	1	1	2	4	4	4	1
Year	31	119	20	30	28	72	30	24	11

CHARLESTON, S.C. Lat. 32° 49′. Long. —79° 56′. Height 52 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	4	1	3	5	4	3	1
Feb.	4	5	3	1	2	6	3	3	1
March	3	3	4	2	3	8	5	2	1
April	2	3	3	2	4	9	3	3	1
May	2	4	6	3	4	7	2	2	1
June	1	3	4	3	5	10	3	1	0
July	1	3	4	2	6	10	3	1	1
Aug.	2	4	4	3	5	8	3	1	1
Sept.	4	7	5	4	3	3	2	1	1
Oct.	7	8	4	2	2	3	2	2	1
Nov.	6	6	3	1	2	4	4	3	1
Dec.	4	5	3	1	3	5	5	3	2
Year	41	56	47	25	42	78	39	25	12

AUGUSTA, GA. Lat. 33° 28′. Long. —81° 54′. Height 183 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	2	2	2	3	5	10
Feb.	2	2	2	2	2	2	4	5	7
March	2	2	1	3	4	3	4	5	7
April	1	3	1	3	4	4	4	4	6
May	2	4	3	5	3	2	2	4	6
June	1	3	2	4	6	4	2	3	5
July	1	3	2	6	5	3	2	2	7
Aug.	2	4	3	3	3	2	2	3	8
Sept.	3	6	3	3	2	1	1	2	9
Oct.	2	5	2	2	2	1	2	4	11
Nov.	3	4	2	2	1	2	3	5	9
Dec.	2	4	1	1	2	4	2	5	10
Year	23	44	23	36	36	30	31	47	95

* Washington Mean Time.

JACKSONVILLE, FLA. Lat. 30° 20′. Long. —81° 39′. Height 43 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	7	1	2	3	4	3	4	3
Feb.	3	6	2	2	3	4	2	3	3
March	1	5	2	3	4	7	4	3	2
April	1	5	2	5	4	6	3	3	1
May	1	8	5	4	3	4	2	2	2
June	0	5	4	5	5	8	1	1	1
July	1	5	3	5	5	8	1	1	2
Aug.	1	7	4	5	4	6	1	1	2
Sept.	2	10	6	3	2	3	1	1	2
Oct.	5	11	3	2	1	2	1	4	2
Nov.	5	7	2	2	2	3	2	5	2
Dec.	5	6	1	2	2	4	4	4	3
Year	29	82	35	40	38	59	25	32	25

PUNTA RASSA, FLA. Lat. 26° 29′. Long. —82° 1′. Height 14 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	8	5	3	4	2	1	3	1
Feb.	3	6	5	3	4	2	2	3	0
March	3	5	5	3	5	3	3	4	0
April	2	4	5	3	5	4	3	4	0
May	2	6	7	2	3	4	4	3	0
June	1	4	8	3	3	4	4	2	1
July	1	5	9	3	2	5	4	1	1
Aug.	2	6	8	2	3	4	3	2	1
Sept.	1	9	9	2	2	3	3	1	0
Oct.	4	13	5	2	2	2	1	2	0
Nov.	5	9	5	1	2	2	2	3	1
Dec.	5	9	5	3	3	1	2	3	0
Year	33	84	76	30	38	36	32	31	5

KEY WEST, FLA. Lat. 24° 34′. Long. —81° 49′. Height 20 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	11	8	3	2	1	1	1	1
Feb.	5	6	8	4	1	1	1	1	1
March	4	6	8	6	2	1	1	2	1
April	4	3	7	8	2	2	1	2	1
May	3	5	10	5	2	2	1	2	1
June	1	2	11	8	3	2	1	1	1
July	1	2	12	8	2	2	1	1	2
Aug.	2	3	10	6	3	2	1	2	2
Sept.	1	6	11	5	2	2	1	1	1
Oct.	3	12	8	2	1	1	1	2	1
Nov.	5	12	7	3	1	1	0	1	0
Dec.	5	12	6	3	1	1	1	1	1
Year	37	80	106	61	22	18	11	17	13

MOBILE, ALA. Lat. 30° 41′. Long. —88° 2′. Height 41 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	3	1	2	8	1	1	3	2
Feb.	9	2	1	2	6	2	1	2	3
March	6	3	1	3	8	3	1	3	3
April	6	2	1	3	10	3	1	3	1
May	6	3	1	4	10	3	1	2	1
June	4	2	2	2	9	5	3	2	1
July	4	2	2	3	8	5	3	2	2
Aug.	5	3	2	3	7	4	2	3	2
Sept.	9	5	3	3	5	1	1	2	1
Oct.	11	4	2	3	5	1	1	2	2
Nov.	10	3	2	3	4	2	1	3	2
Dec.	10	3	2	2	6	1	1	3	3
Year	90	35	20	33	86	31	17	30	23

MEMPHIS, TENN. Lat. 35° 9′. Long. —90° 3′. Height 321 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	2	5	3	4	2	5	3
Feb.	3	4	2	4	3	3	2	4	3
March	2	5	1	5	3	4	3	5	3
April	2	3	2	5	3	5	3	5	2
May	1	4	2	6	4	4	3	4	3
June	1	3	1	5	5	6	3	3	3
July	3	3	1	3	4	7	3	4	3
Aug.	3	5	1	3	2	4	2	6	5
Sept.	4	5	1	3	2	3	2	5	5
Oct.	3	3	2	4	3	4	2	5	5
Nov.	3	4	1	5	4	3	3	5	2
Dec.	3	4	2	4	3	3	3	6	3
Year	31	47	18	52	39	50	31	57	40

CINCINNATI, OHIO. Lat. 39° 6′. Long. —84° 30′. Height 620 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	3	5	4	5	5	5	0
Feb.	3	3	2	4	3	4	4	5	0
March	4	3	3	5	3	3	4	6	0
April	4	4	3	3	3	4	3	5	1
May	3	4	3	5	4	3	3	4	2
June	2	3	3	5	4	6	3	3	1
July	3	4	3	4	4	5	4	3	1
Aug.	4	4	4	5	3	3	3	3	2
Sept.	4	4	2	5	4	3	3	4	1
Oct.	3	3	2	6	4	4	3	4	2
Nov.	2	3	3	5	4	4	4	4	1
Dec.	3	3	3	4	3	5	4	5	1
Year	37	40	34	56	43	49	43	51	12

MARIETTA, OHIO. Lat 39° 25′. Long. —81° 29′. Height (?) ft. 22 Years, 1829-50. Mean of Day Observations.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	1	2	5	7	6	3	...
Feb.	6	1	1	2	3	6	5	4	...
March	7	1	1	2	4	7	5	4	...
April	7	1	2	2	5	6	4	3	...
May	7	1	1	3	6	6	4	3	...
June	6	1	1	2	6	8	4	2	...
July	7	1	2	2	6	8	3	2	...
Aug.	8	1	2	5	7	5	2	1	...
Sept.	7	1	2	3	7	5	3	2	...
Oct.	8	1	2	2	6	6	4	2	...
Nov.	4	1	2	2	4	8	6	3	...
Dec.	5	1	2	2	5	6	6	4	...
Year	78	12	19	29	64	78	52	33	...

ALPENA, MICH. Lat. 45° 5′. Long. —83° 30′. Height 609 ft. 12 Years, 1873-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	3	4	5	8	6	2
Feb.	2	2	2	3	2	3	7	5	2
March	2	2	2	5	2	2	5	9	2
April	3	2	4	5	1	1	4	8	2
May	2	2	4	7	2	2	3	7	2
June	2	1	4	7	2	2	4	6	2
July	2	1	2	6	3	3	6	6	2
Aug.	2	2	3	6	2	2	5	7	2
Sept.	2	1	3	5	3	3	5	6	2
Oct.	2	2	2	5	3	4	6	6	1
Nov.	1	1	1	3	3	6	8	5	2
Dec.	2	1	1	2	3	6	8	7	1
Year	23	18	29	57	30	39	69	78	22

ST. LOUIS, MO. Lat. 38° 38′. Long. —90° 12′. Height 571 ft, 13 Years, 1872-84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	2	2	3	7	3	4	5	1
Feb.	4	3	2	3	5	2	3	5	1
March	6	3	3	4	5	2	3	5	0
April	4	3	2	5	5	3	3	4	1
May	4	3	4	4	8	2	2	3	1
June	3	2	2	4	8	4	3	3	1
July	4	3	2	3	8	4	3	3	1
Aug.	5	3	3	4	7	3	2	3	1
Sept.	5	3	2	4	9	2	1	3	1
Oct.	5	2	2	3	8	3	3	4	1
Nov.	4	2	1	3	7	3	4	5	1
Dec.	4	2	2	4	6	3	4	5	1
Year	52	31	27	44	83	34	35	48	11

* Washington Mean Time.

MARQUETTE, MICH. Lat. 46° 34′. Long. —87° 24′. Height 673 ft. 12 Years, 1873–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	2	4	5	9	6	2
Feb.	3	2	1	2	3	3	6	7	1
March	4	2	2	3	2	2	4	10	2
April	4	3	2	3	2	2	3	9	2
May	3	3	3	3	2	3	2	9	3
June	3	2	3	4	3	2	3	5	5
July	3	2	3	2	2	4	5	7	3
Aug.	3	3	2	3	3	4	4	6	3
Sept.	2	2	2	3	4	4	6	5	2
Oct.	3	2	1	3	4	4	7	5	2
Nov.	2	1	1	3	4	5	8	5	1
Dec.	1	1	1	3	4	4	9	6	2
Year	32	24	22	34	37	42	66	80	28

DULUTH, MINN. Lat. 46° 48′. Long. —92° 6′. Height 672 ft. 12 Years, 1873–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	0	1	10	5	5	3
Feb.	1	7	0	0	1	7	4	4	4
March	2	10	0	0	1	5	3	6	4
April	2	14	1	0	0	3	2	4	4
May	1	16	1	0	0	3	2	3	5
June	1	14	1	0	0	3	3	3	5
July	2	10	1	1	0	4	4	5	4
Aug.	2	12	1	0	0	4	3	5	4
Sept.	2	7	1	1	1	5	3	6	4
Oct.	3	6	1	2	1	6	4	5	3
Nov.	3	3	1	1	1	7	5	6	3
Dec.	2	2	2	0	1	10	4	7	3
Year	23	105	11	5	7	67	42	59	46

BISMARCK, DAK. Lat. 46° 47′. Long. —100° 36′. Height 1694 ft. 11 Years, 1874–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	4	3	2	1	2	10	4
Feb.	4	3	3	3	2	1	2	8	2
March	4	3	4	4	2	2	2	8	2
April	5	4	5	3	2	2	2	6	1
May	4	4	5	5	3	2	2	5	1
June	3	3	5	5	3	1	3	6	1
July	3	3	4	5	4	2	3	5	2
Aug.	4	3	5	4	3	1	3	5	3
Sept.	4	3	4	3	3	1	3	6	3
Oct.	4	3	4	3	3	1	3	7	3
Nov.	4	2	2	3	3	2	2	9	3
Dec.	3	2	3	3	2	1	3	10	4
Year	45	35	48	44	32	17	30	85	29

FORT BENTON, MONT. Lat. 47° 50′. Long —110° 40′. Height 2700 ft. 7 Years, 1873–76, 80–82. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	1	1	0	7	5	2	9
Feb.	2	3	1	0	1	9	3	1	8
March	2	4	2	1	0	7	5	2	8
April	3	3	3	1	1	7	4	2	6
May	2	2	4	2	2	5	5	3	6
June	2	2	3	2	2	6	5	2	6
July	2	3	3	1	1	5	6	2	8
Aug.	2	3	5	1	1	5	4	3	7
Sept.	2	2	3	1	1	5	4	3	9
Oct.	2	3	1	1	1	7	4	2	10
Nov.	2	2	1	0	1	9	4	2	9
Dec.	1	2	1	0	1	11	4	1	10
Year	24	33	28	11	12	83	53	25	96

SAINT PAUL, MINN. Lat. 44° 58′. Long. —93° 3′. Height 801 ft. 12 Years, 1873–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	2	6	3	4	4	6	3
Feb.	3	1	2	5	2	4	4	5	2
March	3	2	2	6	2	3	4	7	2
April	5	2	3	4	2	2	4	6	2
May	5	3	3	7	3	2	2	4	2
June	3	1	3	6	4	3	3	5	2
July	3	1	2	7	4	3	3	5	3
Aug.	3	2	3	7	4	2	3	5	2
Sept.	3	1	2	7	4	3	2	6	2
Oct.	3	1	2	7	4	3	3	6	2
Nov.	2	1	2	6	2	3	4	8	2
Dec.	2	1	2	5	3	4	4	7	3
Year	37	17	28	73	37	36	40	70	27

CHICAGO, ILL. Lat. 41° 52′. Long. —87° 38′. Height 661 ft. 12 Years, 1873–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	2	1	2	4	8	7	4	1
Feb.	2	3	2	2	4	7	5	3	0
March	4	4	3	2	4	5	4	4	1
April	5	5	4	2	3	5	3	2	1
May	5	5	4	4	4	5	2	1	1
June	5	4	3	3	3	7	3	1	1
July	4	6	3	3	3	7	2	2	1
Aug.	3	6	3	4	4	6	2	2	1
Sept.	3	4	2	3	4	8	2	3	1
Oct.	3	3	2	2	6	7	3	4	1
Nov.	2	2	1	3	5	7	6	4	0
Dec.	2	1	1	3	4	7	7	5	1
Year	40	45	29	33	48	79	46	35	10

SALT LAKE CITY, UTAH. Lat. 40° 46′. Long. —111° 54′. Height 4348 ft. 11 Years, 1874–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	6	3	2	2	6	8
Feb.	1	1	1	6	2	1	2	5	9
March	4	2	2	6	2	2	1	6	6
April	3	3	2	5	2	1	1	7	6
May	3	3	2	5	1	2	2	8	5
June	4	3	3	5	1	1	1	7	5
July	5	1	2	6	2	1	1	7	6
Aug.	3	4	2	6	2	1	1	6	6
Sept.	2	3	2	6	2	1	1	7	6
Oct.	2	3	3	5	2	1	1	7	7
Nov.	2	1	2	4	2	2	2	6	9
Dec.	2	1	2	4	2	1	3	6	10
Year	32	26	25	64	23	16	18	78	83

PIKE'S PEAK, COLO.* Lat. 38° 50′. Long. —105° 2′. Height 14,134 ft. 11 Years, 1874–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	0	0	1	9	8	7	1
Feb.	3	1	1	0	1	7	8	6	1
March	2	2	0	0	1	11	7	7	1
April	3	2	0	1	1	11	5	7	0
May	2	2	0	1	2	13	6	4	1
June	2	2	0	1	2	13	6	4	0
July	3	5	1	1	2	9	5	4	1
Aug.	3	5	1	1	3	9	4	4	1
Sept.	3	3	0	1	1	11	5	5	1
Oct.	4	2	1	0	1	10	7	5	1
Nov.	3	4	0	1	1	7	7	6	1
Dec.	4	3	1	1	1	6	7	7	1
Year	35	33	5	8	17	116	75	66	10

CHEYENNE, WYO. Lat. 41° 8′. Long. —104° 48′. Height 6105 ft. 12 Years, 1873–84. Hours 7: 3, 11.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	1	1	2	4	9	9	1
Feb.	2	1	1	1	2	3	9	8	1
March	4	2	1	1	3	3	7	9	1
April	5	1	1	2	3	2	6	9	1
May	4	2	2	3	5	3	4	6	2
June	4	2	1	3	5	3	5	6	1
July	3	2	2	3	6	4	4	6	1
Aug.	3	2	2	3	6	3	5	6	1
Sept.	4	1	1	2	4	4	6	7	1
Oct.	3	1	1	1	3	3	8	9	2
Nov.	4	1	0	0	2	4	9	9	1
Dec.	4	1	0	1	2	4	8	10	1
Year	43	17	13	21	43	40	80	94	14

* Washington Mean Time.

YANKTON, DAK. Lat. 42° 54′. Long. —97° 28′. Height 1228 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	2	2	2	4	3	9	3
Feb.	4	2	2	3	2	3	3	7	2
March	4	3	3	5	2	2	3	7	2
April	4	4	3	4	2	3	3	6	1
May	4	3	3	5	5	3	2	5	1
June	2	3	2	5	5	3	3	5	2
July	2	3	3	5	6	3	2	4	3
Aug.	3	3	4	5	5	3	2	3	3
Sept.	3	3	3	4	4	3	2	6	3
Oct.	3	3	2	3	4	3	3	8	2
Nov.	3	3	2	3	2	3	3	9	2
Dec.	3	2	2	2	2	4	3	10	3
Year	38	34	31	46	41	37	32	79	27

OMAHA, NEBR. Lat. 41° 16′. Long. —95° 56′. Height 1113 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	1	2	7	3	2	7	2
Feb.	6	1	1	3	5	2	2	6	2
March	8	2	1	4	4	2	1	7	2
April	7	3	2	5	3	2	1	5	2
May	5	2	3	7	6	2	1	3	2
June	4	1	2	6	6	2	2	4	3
July	5	2	1	5	9	3	1	3	2
Aug.	5	2	1	6	9	2	1	2	3
Sept.	6	1	1	5	8	2	1	4	2
Oct.	5	1	1	4	7	2	2	6	3
Nov.	6	1	1	2	7	2	2	7	2
Dec.	6	1	1	3	5	3	2	7	3
Year	69	18	16	52	76	27	18	61	28

LEAVENWORTH, KANS. Lat. 39° 19′. Long. —94° 57′. Height 842 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	1	1	2	9	1	1	6	3
Feb.	6	2	1	2	7	1	1	6	2
March	7	2	2	4	6	1	1	7	1
April	6	3	2	4	6	1	1	5	2
May	4	2	2	6	9	1	1	3	3
June	4	1	2	4	10	2	0	3	4
July	5	2	2	3	11	2	1	1	4
Aug.	6	1	1	4	9	2	1	2	5
Sept.	5	1	1	4	10	1	0	3	5
Oct.	5	1	1	4	9	1	1	4	5
Nov.	6	1	1	2	8	2	1	6	3
Dec.	6	1	1	3	7	1	1	7	4
Year	67	18	17	42	101	16	10	53	41

DODGE CITY, KANS. Lat. 37° 45′. Long. —100° 0′. Height 2517 ft. 10 Years, 1875–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	2	1	3	5	4	3	4	1
Feb.	6	3	1	3	4	3	3	4	1
March	6	4	2	4	4	3	2	5	1
April	7	3	2	4	5	3	2	3	1
May	5	3	2	5	7	3	2	3	1
June	3	3	3	5	9	3	2	1	1
July	2	4	4	7	9	3	1	0	1
Aug.	2	3	3	8	11	2	1	0	1
Sept.	3	4	2	5	10	2	1	2	1
Oct.	6	3	1	4	7	3	2	4	1
Nov.	8	3	1	3	4	3	2	4	2
Dec.	6	3	1	2	5	3	4	5	2
Year	62	38	23	53	80	35	25	35	14

SANTA FÉ, MEX. Lat. 35° 41′. Long. —105° 57′. Height 7106 ft. 11 Years, 1873–83. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	4	3	3	2	3	1	4	3
Feb.	6	2	3	3	2	3	2	5	2
March	6	3	4	3	2	5	2	4	2
April	3	2	4	4	3	5	3	4	2
May	3	2	5	5	4	6	2	2	2
June	3	3	4	5	3	6	2	2	2
July	3	4	5	5	3	4	2	2	3
Aug.	3	4	6	4	3	4	1	3	3
Sept.	2	3	6	4	3	4	2	2	4
Oct.	4	3	5	4	3	4	2	3	3
Nov.	6	3	2	3	2	4	2	4	3
Dec.	8	4	3	2	2	3	1	4	4
Year	55	37	51	45	32	51	22	39	33

SHREEVEPORT, LA. Lat. 32° 30′. Long. —93° 40′. Height 227 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	3	6	2	2	4	5
Feb.	4	3	3	3	6	1	2	2	4
March	3	3	3	4	7	2	3	3	3
April	3	2	3	4	7	2	3	3	3
May	2	2	4	6	8	2	1	2	4
June	2	1	2	5	9	3	2	2	4
July	3	2	4	5	7	4	2	1	3
Aug.	4	3	4	4	4	2	2	2	6
Sept.	5	4	4	4	4	1	1	1	6
Oct.	4	3	3	5	5	1	1	2	7
Nov.	5	3	2	3	6	1	2	3	5
Dec.	4	3	3	3	6	2	2	3	5
Year	43	32	37	49	75	23	23	28	55

NEW ORLEANS, LA. Lat. 29° 58′. Long. —90° 4′. Height 52 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	4	4	5	4	2	2	3	1
Feb.	5	3	4	4	3	3	2	3	1
March	4	2	4	7	5	3	2	3	1
April	4	2	3	7	5	3	2	3	1
May	3	3	5	7	5	2	2	2	2
June	2	2	4	6	5	5	3	2	1
July	2	3	4	6	3	4	4	3	2
Aug.	3	3	5	5	3	3	3	3	3
Sept.	5	5	8	5	2	1	1	2	1
Oct.	6	6	7	4	2	1	1	3	1
Nov.	6	5	5	4	2	2	1	4	1
Dec.	6	4	6	4	3	2	1	4	1
Year	52	42	59	64	42	31	24	35	16

GALVESTON, TEX. Lat. 29° 18′. Long. —94° 47′. Height 40 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	4	4	6	4	1	1	3	1
Feb.	5	3	4	6	6	1	1	2	0
March	3	3	4	10	7	1	1	2	0
April	3	2	2	9	8	2	1	2	1
May	2	2	3	12	8	2	1	1	0
June	1	1	1	9	13	2	1	1	1
July	1	2	2	7	11	5	1	1	1
Aug.	2	2	3	9	8	3	2	1	1
Sept.	4	4	5	8	5	1	1	1	1
Oct.	5	5	5	8	5	1	0	1	1
Nov.	6	5	5	5	5	1	1	2	0
Dec.	6	4	6	5	4	2	1	3	0
Year	45	37	44	94	84	22	12	20	7

BROWNSVILLE, TEX. Lat. 25° 53′. Long. —97° 26′. Height 59 ft. 4 Years, 1881–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	2	2	2	7	1	0	3	5
Feb.	6	2	2	6	8	1	0	1	2
March	4	2	4	7	8	1	0	2	3
April	2	3	4	10	6	1	0	1	3
May	1	2	6	12	6	0	0	1	3
June	1	1	4	11	8	1	0	0	4
July	0	1	2	15	9	1	0	0	3
Aug.	2	1	5	9	6	1	0	0	7
Sept.	4	3	3	6	3	1	1	1	8
Oct.	4	2	3	6	5	1	0	1	9
Nov.	11	2	2	3	5	0	0	2	5
Dec.	9	3	2	2	8	1	0	1	5
Year	53	24	39	89	79	10	1	13	57

* Washington Mean Time.

FORT THOMAS, MEX. Lat. 33° 4′. Long. —110° 2′. Height 2710 ft. 4½ Years, 1882–86. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	4	8	3	3	2	7
Feb.	2	1	3	2	4	2	8	1	5
March	3	0	3	2	3	1	9	2	8
April	2	0	2	1	2	3	8	3	9
May	2	1	2	2	3	4	8	3	6
June	1	1	3	1	2	2	6	4	10
July	2	2	2	3	2	2	5	4	9
Aug.	1	1	3	4	5	2	5	3	7
Sept.	1	1	3	5	6	3	4	1	6
Oct.	1	1	3	5	5	3	4	2	7
Nov.	1	1	2	5	7	3	5	2	4
Dec.	1	1	4	7	5	3	2	3	5
Year	18	11	32	41	52	31	67	30	83

CONCHO, TEX. Lat. 31° 25′. Long. —100° 24′. Height 1900 ft. 4 Years, 1879, 80–83. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	0	1	4	6	2	3	7
Feb.	3	4	1	1	5	4	2	3	5
March	2	4	1	2	7	5	3	3	4
April	2	4	2	3	6	4	3	3	3
May	2	3	3	4	8	3	2	2	4
June	0	3	2	7	12	1	1	1	3
July	0	4	4	7	11	1	0	0	4
Aug.	1	4	4	6	9	2	0	1	4
Sept.	2	5	2	3	10	1	1	2	4
Oct.	2	5	2	3	9	3	1	2	4
Nov.	4	3	1	2	5	4	3	3	5
Dec.	3	6	1	1	4	6	3	3	4
Year	25	49	23	40	90	40	21	26	51

PIOCHE, NEV. Lat. 37° 57′. Long. —114° 26′. Height 6110 ft. 6 Years, 1878–83. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	1	0	0	9	3	2	8	2
Feb.	5	1	0	1	9	2	3	6	1
March	6	1	1	1	9	4	2	5	2
April	5	1	1	1	11	4	2	4	1
May	6	1	0	1	11	4	3	3	2
June	4	1	1	1	12	4	1	4	2
July	2	1	0	2	14	5	2	3	2
Aug.	2	1	1	3	15	3	2	3	1
Sept.	2	1	0	2	12	5	2	4	2
Oct.	5	1	0	1	11	3	2	6	2
Nov.	7	1	1	1	8	2	2	6	2
Dec.	5	1	0	1	9	3	2	7	3
Year	55	12	5	15	130	42	25	59	22

FORT YUMA, ARIZ. Lat. 32° 45′. Long. —114° 36′. Height 141 ft. 4 Years, 1881–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	6	1	2	2	1	2	4	3
Feb.	6	5	1	2	2	3	3	4	2
March	5	3	1	2	4	4	3	5	4
April	2	2	1	3	3	6	5	5	3
May	2	2	1	4	4	5	4	6	3
June	1	2	2	5	3	6	5	2	4
July	1	1	1	9	7	6	2	1	3
Aug.	1	1	2	9	5	5	1	2	5
Sept.	2	4	2	3	2	5	3	3	6
Oct.	4	6	2	2	1	4	3	4	5
Nov.	9	7	1	1	1	2	2	3	4
Dec.	10	7	2	1	1	1	2	4	3
Year	53	46	17	43	35	48	35	43	45

SAN DIEGO, CAL. Lat. 32° 43′. Long. —117° 10′. Height 67 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	7	3	1	2	2	4	5	3
Feb.	4	5	2	1	3	2	4	5	2
March	4	3	2	1	2	3	7	6	3
April	3	2	1	1	2	4	8	6	3
May	2	1	1	1	4	6	9	5	2
June	2	1	0	1	4	6	8	6	2
July	2	2	1	1	3	4	8	7	3
Aug.	3	1	0	0	3	5	9	7	3
Sept.	3	1	1	0	2	3	7	9	4
Oct.	5	3	1	1	1	3	6	7	4
Nov.	4	6	3	1	1	2	5	5	3
Dec.	4	7	3	1	2	2	4	5	3
Year	40	39	18	10	29	42	79	73	35

VISALIA, CAL. Lat. 36° 20′. Long. —119° 17′. Height 348 ft. 6 Years, 1878–83. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	4	6	3	2	3	6	3
Feb.	2	1	2	5	3	2	3	7	3
March	3	1	2	4	3	2	3	9	4
April	3	1	2	4	2	2	2	11	3
May	4	1	1	2	1	2	3	15	2
June	3	1	1	2	1	2	4	14	2
July	3	1	1	2	2	3	5	13	1
Aug.	2	0	1	3	3	2	5	13	2
Sept.	2	1	1	5	2	2	3	10	4
Oct.	3	1	2	6	3	2	3	8	3
Nov.	3	1	3	5	2	3	2	7	4
Dec.	2	1	3	5	4	2	2	7	5
Year	33	11	23	49	29	26	38	120	36

SAN FRANCISCO, CAL. Lat. 37° 48′. Long. —122° 26′. Height 60 ft. 12 Years, 1873–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	3	1	5	3	3	3	5	2
Feb.	4	2	1	4	1	4	5	5	2
March	2	1	1	2	2	7	10	4	2
April	1	0	0	1	2	8	13	3	2
May	1	0	0	1	1	10	15	2	1
June	0	0	0	1	1	13	13	1	1
July	0	0	0	0	1	16	13	0	1
Aug.	0	0	0	0	1	17	12	0	1
Sept.	0	0	0	1	1	15	10	1	2
Oct.	2	1	0	1	1	10	9	4	3
Nov.	5	2	1	3	2	4	5	5	3
Dec.	7	3	1	3	2	3	3	6	3
Year	28	12	5	22	18	110	111	36	23

ROSEBURG, OREG. Lat. 43° 13′. Long. —123° 20′. Height 511 ft. 8 Years, 1877–84. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	4	2	5	5	2	2	9
Feb.	2	1	2	2	4	4	2	4	7
March	3	2	2	1	3	5	3	4	8
April	3	1	2	1	3	5	2	6	7
May	7	2	1	0	1	3	2	7	8
June	11	2	1	0	0	1	2	6	7
July	10	3	1	0	0	1	1	7	8
Aug.	10	2	1	0	0	1	2	7	8
Sept.	6	3	1	1	1	1	2	6	9
Oct.	3	2	2	2	2	3	3	3	11
Nov.	2	2	3	2	2	4	2	3	10
Dec.	2	2	4	2	4	4	2	3	8
Year	60	23	24	13	25	37	25	58	100

CAPE MENDOCINO, CAL. Lat. 40° 26′. Long. —124° 24′. Height 637 ft. 4 Years, 1883–86. Hours 7 : 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	1	1	10	5	0	0	5	1
Feb.	5	0	1	8	2	0	1	10	1
March	6	1	2	7	2	1	1	10	1
April	5	0	1	8	2	1	0	12	1
May	6	0	0	7	2	1	0	13	2
June	10	0	0	3	1	0	0	15	1
July	13	0	0	2	2	0	0	12	2
Aug.	18	0	0	2	1	0	0	9	1
Sept.	16	1	0	3	2	0	0	7	1
Oct.	14	1	0	6	4	0	0	5	1
Nov.	10	2	0	7	5	0	0	5	1
Dec.	6	1	0	13	6	0	0	4	1
Year	117	7	5	76	34	3	2	107	14

* Washington Mean Time.

FORT CANBY, WASH.
Lat. 46° 16′. Long. —124° 4′.
Height 179 ft.
3½ Years, 1883–86. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	8	10	3	2	3	1	1
Feb.	4	1	2	5	7	4	4	1	0
March	4	1	3	3	6	6	6	1	1
April	5	2	1	3	6	3	8	1	1
May	7	1	1	1	6	3	11	1	0
June	6	1	1	1	6	2	11	2	0
July	7	1	1	1	5	2	11	3	0
Aug.	7	2	1	1	5	4	8	3	0
Sept.	4	2	1	3	9	2	7	2	0
Oct.	5	1	2	4	9	2	6	1	1
Nov.	2	1	4	8	7	3	4	1	0
Dec.	2	3	2	10	6	2	3	2	1
Year	55	17	27	50	75	35	82	19	5

TATOOSH IS., WASH.
Lat. 48° 23′. Long. —124° 44′.
Height 86 ft.
3¼ Years, 1883–86. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	1	17	5	2	3	1	2	0
Feb.	0	1	10	4	3	5	2	3	0
March	0	2	8	3	4	6	2	4	2
April	0	2	7	4	3	7	3	3	1
May	0	2	5	4	3	8	6	3	0
June	0	1	2	3	3	14	4	3	0
July	0	1	2	4	4	13	3	2	2
Aug.	0	2	3	3	6	12	2	2	1
Sept.	0	2	8	4	4	8	2	1	1
Oct.	0	2	12	5	2	5	2	2	1
Nov.	0	0	13	7	2	4	3	1	0
Dec.	0	1	12	6	3	4	2	3	0
Year	0	17	99	52	39	89	32	29	8

WINNEMUCCA, NEV.
Lat. 41° 0′. Long. —117° 41′.
Height 4327 ft.
6 Years, 1878–83. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	10	1	0	2	13	1	1	1
Feb.	2	8	1	1	2	10	2	1	1
March	3	9	1	0	2	12	2	1	1
April	2	6	1	0	3	12	3	1	2
May	2	6	2	0	2	11	4	2	2
June	3	7	1	1	2	10	2	3	1
July	3	6	1	0	2	12	4	2	1
Aug.	3	6	1	0	3	12	4	1	1
Sept.	3	6	2	1	2	11	3	1	1
Oct.	4	8	1	1	2	10	3	1	1
Nov.	3	11	2	0	2	9	1	1	1
Dec.	2	12	2	0	2	9	2	1	1
Year	32	95	16	4	26	131	31	16	14

BOISE CITY, IDAHO.
Lat. 43° 37′. Long. —116° 8′.
Height 2750 ft.
7 Years, 1878–84. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	2	7	4	1	5	6	2
Feb.	3	2	3	6	2	1	4	5	2
March	2	2	2	8	2	2	6	5	2
April	2	2	2	5	1	2	7	7	2
May	4	2	2	3	1	1	7	10	1
June	3	2	2	3	1	1	7	9	2
July	3	2	2	3	2	2	5	7	5
Aug.	3	2	2	4	3	2	5	8	2
Sept.	3	2	1	5	2	2	5	8	2
Oct.	2	2	2	6	3	1	4	8	3
Nov.	2	1	2	6	3	1	5	8	2
Dec.	3	1	2	6	1	2	6	7	3
Year	33	21	24	62	25	18	66	88	28

PORTLAND, OREG.
Lat. 45° 32′. Long. —122° 43′.
Height 67 ft.
12 Years, 1873–84. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	1	4	3	9	3	1	3	4
Feb.	3	1	2	3	8	2	1	4	4
March	2	1	2	3	9	3	1	5	5
April	4	1	1	3	6	3	1	5	6
May	4	1	1	1	7	3	2	7	5
June	6	1	1	2	5	2	1	8	4
July	8	1	1	1	4	1	1	11	3
Aug.	6	1	1	1	4	1	2	10	5
Sept.	4	1	1	1	6	2	2	7	6
Oct.	3	1	1	2	7	3	1	6	7
Nov.	2	1	2	3	9	2	2	3	6
Dec.	3	2	4	3	8	3	1	3	4
Year	48	13	21	26	82	28	10	72	59

UMATILLA, OREG.
Lat. 45° 55′. Long. —119° 20.
Height 340 ft.
5 Years, 1878–82. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	5	6	2	4	5	2	4
Feb.	1	2	5	6	1	4	6	2	1
March	1	3	4	4	2	6	8	2	1
April	1	2	4	3	1	6	9	2	2
May	1	2	3	3	1	7	11	2	1
June	1	2	4	1	0	9	10	2	1
July	1	2	4	1	0	8	10	3	2
Aug.	2	2	3	3	1	6	9	2	3
Sept.	1	2	3	6	1	4	8	3	2
Oct.	2	1	2	8	2	5	7	2	2
Nov.	2	2	4	7	2	3	6	1	3
Dec.	1	3	5	5	2	4	5	2	4
Year	15	25	46	53	15	66	94	25	26

BERING IS.
Lat. 55° 12′. Long. —165° 55′.
Height 20 ft.
4 Years, 1882–86. Hour 11:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	11	6	1	2	1	0	1	1
Feb.	3	8	7	4	2	2	1	1	0
March	7	5	8	2	2	3	1	3	0
April	5	4	3	3	5	3	2	5	0
May	5	6	5	1	6	2	1	5	0
June	5	4	4	2	10	4	0	1	0
July	2	4	4	2	11	6	0	1	1
Aug.	1	3	4	1	14	3	1	2	2
Sept.	5	1	2	1	8	7	2	2	2
Oct.	6	3	1	2	6	2	0	9	2
Nov.	3	2	6	1	4	6	2	6	0
Dec.	5	6	8	2	3	3	1	2	1
Year	55	57	58	22	73	42	11	38	9

UNALASKA, ALASKA.
Lat. 53° 53′. Long. —166° 32′.
Height 13 ft.
3 Years, 1882–83, 85–86. Hours 7: 3, 11.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	4	10	6	4	1	2	1
Feb.	8	1	1	3	3	3	1	7	1
March	4	1	2	4	5	6	2	6	1
April	2	2	1	6	2	8	3	6	0
May	3	3	1	8	4	7	2	3	0
June	3	6	1	3	2	7	3	4	1
July	3	6	2	3	2	10	1	3	1
Aug.	3	6	0	5	2	9	2	3	1
Sept.	2	2	1	5	2	6	4	7	1
Oct.	2	2	0	5	6	8	2	5	1
Nov.	2	1	1	2	7	9	3	5	0
Dec.	4	1	2	3	6	7	3	4	1
Year	38	32	16	57	47	84	27	55	9

FAYAL.
Lat. 38° 32′. Long. —30° 59′.
Height 208 ft.
5 Years, 1881–85. Hours 10: 6.

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	2	2	2	7	8	5	...
Feb.	3	3	1	2	2	8	5	4	...
March	2	5	2	3	4	7	4	4	...
April	4	5	0	1	2	8	6	4	...
May	3	6	1	0	2	10	7	2	...
June	1	2	1	2	10	6	7	1	...
July	3	6	2	1	2	6	7	4	...
Aug.	3	11	1	0	3	6	5	2	...
Sept.	3	7	2	2	2	7	4	3	...
Oct.	3	8	4	5	3	4	3	1	...
Nov.	4	4	1	1	2	7	5	6	...
Dec.	5	4	2	2	3	8	4	3	...
Year	36	64	19	21	37	84	65	39	...

* Washington Mean Time.

Month.	FUNCHAL. Lat. 32° 28′. Long. −16° 55′. Height 83 ft. 5 Years, 1866–70. Hours 9 : 3, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	3	4	1	6	8	1	2
Feb.	2	2	4	4	1	7	5	1	2
March	1	3	2	3	2	10	7	1	2
April	1	2	2	4	3	12	4	1	1
May	1	1	0	3	3	14	6	1	2
June	1	1	1	2	3	17	3	0	2
July	1	0	0	1	5	18	2	1	3
Aug.	1	1	1	1	1	20	2	1	3
Sept.	2	1	1	2	2	16	2	1	3
Oct.	2	3	3	3	2	12	2	1	3
Nov.	2	2	2	2	2	8	8	1	3
Dec.	3	3	3	4	2	6	7	1	2
Year	20	22	22	33	27	146	56	11	28

Month.	PONTA DELGADA. Lat. 37° 45′. Long. −25° 41′. Height 66 ft. 6 Years, 1865–70. Hours 9 : 3, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	4	2	2	3	7	5	4	0
Feb.	3	5	3	3	5	4	3	2	0
March	4	7	3	4	4	2	3	4	0
April	5	5	1	2	5	4	4	4	0
May	6	4	0	1	2	5	7	6	0
June	4	8	1	3	4	3	4	1	2
July	6	9	1	2	2	3	5	2	1
Aug.	5	12	2	2	1	3	3	3	0
Sept.	6	7	1	2	2	4	4	3	1
Oct.	4	7	2	4	4	4	3	3	0
Nov.	5	6	2	2	5	4	4	2	0
Dec.	5	6	2	2	3	6	4	3	0
Year	57	80	20	29	40	49	49	37	4

Month.	BERMUDA. Lat. 32° 17′. Long. −64° 14′. Height 120 ft. 11 Years, 1852–62. Hours 9½ : 3½.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	1	2	3	8	4	6	0
Feb.	4	3	2	2	3	7	3	4	0
March	4	3	1	2	3	7	6	5	0
April	4	3	2	1	4	6	5	5	0
May	2	4	3	3	4	7	4	3	1
June	1	3	2	3	5	8	5	3	0
July	1	1	2	4	7	10	4	2	0
Aug.	1	3	2	3	6	9	5	2	0
Sept.	3	7	4	2	5	5	2	2	0
Oct.	3	6	4	4	4	5	2	3	0
Nov.	5	4	3	2	3	5	4	4	0
Dec.	4	5	2	2	3	6	4	5	0
Year	36	45	28	30	50	83	48	44	1

Month.	NASSAU. Lat. 25° 5′. Long. −77° 21. Height 44 ft. 15 Years, 1870–84. Hours 9 : 3.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	12	2	7	1	2	0	3	2
Feb.	1	12	3	5	1	2	0	4	0
March	2	10	2	9	2	2	1	3	0
April	2	9	2	8	2	2	1	4	0
May	2	9	3	8	2	2	1	3	1
June	3	7	6	10	2	1	0	1	0
July	1	8	4	12	2	2	0	1	1
Aug.	1	8	4	11	2	2	0	2	1
Sept.	1	10	4	10	1	2	0	1	1
Oct.	1	15	4	5	1	1	1	2	1
Nov.	2	13	4	4	1	2	0	3	1
Dec.	2	14	3	4	1	2	0	4	1
Year	20	127	41	93	18	22	4	31	9

Month.	MATAMORAS, MEX. Lat. 25° 56′. Long. − 97° 36′. Height (?) ft. Hours, S.-R., 9 : 3, 9. 1½ Years, 1847–48.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	3	3	2	9	2	1	1	...
Feb.	6	5	6	4	3	2	1	1	...
March	6	1	7	5	9	1	1	1	...
April	3	2	13	6	3	1	1	1	...
May	1	2	13	3	10	1	1	0	...
June	0	3	26	1	0	0	0	0	...
July	0	1	30	0	0	0	0	0	...
Aug.	0	0	31	0	0	0	0	0	...
Sept.	6	5	19	0	0	0	0	0	...
Oct.	8	6	15	1	1	0	0	0	...
Nov.	14	3	8	0	4	0	1	0	...
Dec.	16	0	4	1	10	0	0	0	...
Year	70	31	175	23	49	7	6	4	...

Month.	MATANZAS. Lat. 23° 3′. Long. −81° 30′. Height (?) ft. 4 Years, 1832–35. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	10	3	2	5	0	0	0	2
Feb.	11	7	5	0	0	0	0	1	4
March	7	12	5	0	3	0	0	0	4
April	1	18	1	0	3	0	0	0	7
May	0	23	2	0	1	0	0	0	5
June	0	9	0	0	0	0	0	0	0
July	0	9	0	0	0	0	0	0	0
Aug.	0	13	2	1	1	0	0	0	0
Sept.	0	12	0	0	2	2	0	1	0
Oct.	10	18	3	0	0	0	0	0	0
Nov.	4	22	4	0	0	0	0	0	0
Dec.	8	12	4	0	2	0	0	0	0
Year	...	...	...	...	...	...	...	...	...

Month.	SANTIAGO DE CUBA. Lat. 19° 55′. Long. −75° 50′. Height 21 ft. 2⅔ Years, 1880–83. Hour 7 :								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	21	4	0	0	0	0	0	1	5
Feb.	13	2	0	0	0	0	0	2	11
March	14	1	0	0	0	0	0	1	15
April	10	0	0	0	0	0	0	0	20
May	10	0	0	0	0	0	0	1	20
June	7	0	0	0	0	0	0	0	23
July	8	3	0	0	0	1	0	1	18
Aug.	5	1	0	0	0	0	0	1	24
Sept.	10	2	0	1	0	0	0	1	16
Oct.	4	4	1	1	0	3	3	3	12
Nov.	18	3	0	0	0	0	0	1	8
Dec.	13	1	0	0	0	0	0	2	15
Year	133	21	1	2	0	4	3	14	187

Month.	HAVANA. Lat. 23° 8′. Long. −82° 23′. Height 62 ft. 1 Year, 1875. Hours various.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	6	10	4	2	0	0	0	6
Feb.	4	6	7	3	2	1	0	1	4
March	3	5	9	5	4	0	0	1	4
April	6	5	7	3	4	1	1	2	1
May	5	4	7	5	4	1	1	2	2
June	4	6	10	5	2	0	0	0	3
July	3	6	13	4	1	0	0	0	4
Aug.	4	5	10	6	2	0	0	1	3
Sept.	3	5	9	7	3	1	0	0	2
Oct.	8	7	8	2	1	0	0	2	3
Nov.	2	6	10	7	1	0	0	0	4
Dec.	3	3	11	5	3	1	1	3	1
Year	48	64	111	56	29	5	3	12	37

Month.	NEVASSA. Lat. 19° 25′. Long. −75° 3′. Height 77 ft. 8 Months, 1882–83. Hour 8 :								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	27	4	0	0	0	0	0	0
Feb.	...	...	...	...	...	...	...	...	...
March	0	20	11	0	0	0	0	0	0
April	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...
July	0	8	23	0	0	0	0	0	0
Aug.	0	12	19	0	0	0	0	0	0
Sept.	1	14	15	0	0	0	0	0	0
Oct.	1	15	14	0	0	0	1	0	0
Nov.	0	24	5	0	0	0	0	0	1
Dec.	0	27	4	0	0	0	0	0	0
Year	...	...	...	...	...	...	...	...	...

POINTE-A-PITRE. Lat. 16° 14′. Long. —61° 31′. Height 13 feet. 9 Months, 1885. Hours 8 : 4, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...
April	1	0	1	9	1	2	0	0	0
May	1	2	8	18	1	0	0	1	0
June	0	14	11	5	0	0	0	0	0
July	0	14	15	1	0	0	0	0	1
Aug.	0	15	15	1	0	0	0	0	0
Sept.	2	11	11	2	0	4	0	0	0
Oct.	1	10	10	7	1	2	0	0	0
Nov.	0	13	13	1	3	0	0	0	0
Dec.	0	12	14	2	1	2	0	0	0
Year	...	...	...	...	...	...	...	...	...

JAMAICA. Lat. 18° 6′. Long. —76° 42′. Height 3800 ft. 15 Years, 1870–84. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	6	6	4	0	1	1	1	11
Feb.	1	5	4	4	1	0	0	1	12
March	1	6	4	3	2	0	1	1	13
April	1	6	5	4	1	1	1	0	11
May	0	5	6	4	1	1	0	0	14
June	0	6	5	5	1	1	0	0	12
July	0	6	6	5	1	0	1	0	12
Aug.	0	7	4	5	1	0	1	0	13
Sept.	1	6	5	6	0	0	0	0	12
Oct.	1	6	6	5	0	1	0	1	11
Nov.	1	5	6	4	0	0	1	1	12
Dec.	2	6	5	4	1	0	0	1	12
Year	9	70	62	53	9	5	6	6	145

UP PARK CAMP, JAMAICA. Lat. 18° 0′. Long. —76° 56′. Height 225 ft. 5 Years, 1853–59. Hours 9½ : 3½.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	13	2	8	0	0	0	1	...
Feb.	6	7	1	10	0	1	0	3	...
March	4	5	1	14	1	1	1	4	...
April	2	4	2	17	0	2	1	2	...
May	2	8	2	17	0	0	0	2	...
June	3	6	1	15	1	1	0	3	...
July	4	10	2	11	0	1	1	2	...
Aug.	5	6	2	15	0	1	1	1	...
Sept.	2	9	3	13	0	1	1	1	...
Oct.	4	10	2	12	0	0	0	3	...
Nov.	6	14	2	5	1	0	0	2	...
Dec.	7	17	2	4	0	0	0	1	...
Year	52	109	22	141	3	8	5	25	...

ROSS' VIEW, JAMAICA. Lat. 18° 3′. Long. —76° 44′. Height 951 ft. 5 Years, 1869–73. Hours 6, N. : 6.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	16	5	2	2	0	1	...
Feb.	1	4	16	3	2	1	0	1	...
March	2	6	16	4	1	1	0	1	...
April	1	6	16	4	1	1	0	1	...
May	0	4	17	4	2	2	1	1	...
June	1	3	17	5	2	1	0	1	...
July	1	4	17	5	2	1	0	1	...
Aug.	1	5	17	3	3	1	0	1	...
Sept.	1	4	17	3	2	1	1	1	...
Oct.	1	4	16	4	3	1	1	1	...
Nov.	1	4	16	3	3	1	1	1	...
Dec.	1	5	14	4	3	2	1	1	...
Year	12	53	195	47	26	15	5	12	...

PORTO RICO. Lat. 18° 18′. Long. —66° 30′. Height 81 ft. 11½ Years, 1874–85. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	7	18	4	1	0	0	0	0
Feb.	1	7	14	4	1	0	0	1	0
March	1	6	15	5	1	1	1	1	0
April	1	5	16	4	1	1	0	1	1
May	1	3	18	7	1	0	1	0	0
June	2	1	18	6	1	1	0	0	1
July	0	2	21	6	1	0	1	0	0
Aug.	1	3	17	8	1	0	0	1	0
Sept.	1	3	15	8	1	0	1	0	1
Oct.	1	4	14	8	1	1	0	1	1
Nov.	3	7	13	4	1	1	0	1	0
Dec.	3	8	13	5	1	0	1	0	0
Year	16	56	192	69	12	5	5	6	4

BARBADOES. Lat. 13° 4′. Long. —59° 40′. Height 25 ft. 15 Years, 1870–84. Hours 9 : 3.

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	28	1	1	0	0	0	0	...
Feb.	0	23	2	2	0	0	0	1	...
March	0	27	3	1	0	0	0	0	...
April	0	25	4	1	0	0	0	0	...
May	0	23	5	3	0	0	0	0	...
June	0	25	2	3	0	0	0	0	...
July	0	25	4	2	0	0	0	0	...
Aug.	0	23	3	5	0	0	0	0	...
Sept.	0	20	4	6	0	0	0	0	...
Oct.	0	19	3	9	0	0	0	0	...
Nov.	1	23	3	3	0	0	0	0	...
Dec.	1	26	3	1	0	0	0	0	...
Year	3	287	37	37	0	0	0	1	...

BELIZE. Lat. 17° 30′. Long. —88° 18′. Height 27 ft. 5 Years, 1866–70. Hours 9 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	7	5	12	0	0	0	1	0
Feb.	7	4	4	11	0	0	1	1	0
March	3	6	8	13	0	0	0	1	0
April	2	4	13	10	0	0	0	1	0
May	1	3	14	12	0	0	0	1	0
June	1	3	13	10	1	1	0	1	0
July	1	3	15	12	0	0	0	0	0
Aug.	3	5	8	11	3	0	0	1	0
Sept.	3	4	10	11	0	0	0	2	0
Oct.	9	8	4	3	1	0	1	5	0
Nov.	14	5	3	2	0	0	1	5	0
Dec.	4	10	4	6	0	0	1	5	1
Year	54	62	101	113	5	1	4	24	1

CORDOVA, MEX. Lat. 18° 51′. Long. —96° 54′. Height 2879 ft. 2 Years, 1858–59. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	9	2	2	1	5	2	4	0
Feb.	3	9	2	1	3	5	1	4	0
March	5	9	3	2	1	5	3	3	0
April	3	9	2	1	2	7	3	1	2
May	2	8	1	2	1	4	6	5	2
June	3	12	4	2	1	2	2	4	0
July	3	12	2	3	2	3	2	3	1
Aug.	2	11	3	3	1	5	1	4	1
Sept.	6	14	1	1	1	2	2	3	0
Oct.	5	11	2	2	1	2	3	4	1
Nov.	4	10	1	2	2	4	2	5	0
Dec.	5	12	1	2	2	4	2	3	0
Year	47	126	24	23	18	48	29	43	7

GUATEMALA. Lat. 14° 38′. Long. —90° 31′. Height 4856 ft. 4 Years, 1879–82. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	18	6	0	0	1	2	0	0	4
Feb.	17	7	0	0	2	1	0	0	1
March	7	10	1	0	1	6	0	1	5
April	9	5	0	0	5	5	0	1	5
May	6	6	0	1	5	6	0	1	6
June	6	5	1	1	4	6	1	0	6
July	12	9	0	1	2	2	0	1	4
Aug.	9	6	1	1	4	6	0	1	3
Sept.	8	5	1	1	4	6	1	0	4
Oct.	10	6	0	0	3	4	0	1	7
Nov.	19	8	0	1	0	1	0	0	1
Dec.	21	6	0	1	1	1	0	0	1
Year	142	79	4	7	32	46	2	6	47

COLON.
Lat. 9° 22′. Long. —79° 55′.
Height 164 ft.
5 Years, 1881–85. Hours 6 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	17	12	0	0	1	0	0	1	0
Feb.	14	14	0	0	0	0	0	0	0
March	16	13	0	0	1	0	0	0	1
April	18	8	0	1	1	0	0	1	1
May	9	4	1	2	6	1	2	5	1
June	4	2	1	2	8	2	3	5	3
July	7	3	1	1	5	2	3	5	4
Aug.	6	2	0	2	4	5	4	4	4
Sept.	3	1	1	2	8	5	3	3	4
Oct.	2	0	4	3	11	3	2	3	3
Nov.	4	0	2	2	9	3	5	4	1
Dec.	16	5	1	1	2	1	2	3	0
Year	116	64	11	16	56	22	24	34	22

GAMBOA.
Lat. 9° 10′. Long. —79° 43′.
Height 98 ft.
$3\frac{1}{4}$ Years, 1881–82, 84–85. Hours 7, 11 : 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	13	5	1	0	0	0	1	3	8
Feb.	11	4	1	0	0	1	1	3	7
March	14	2	1	0	0	0	0	5	9
April	9	4	1	0	0	0	1	7	8
May	7	7	0	1	1	1	0	6	8
June	2	8	1	2	2	1	1	5	8
July	3	4	0	1	1	2	3	6	11
Aug.	4	5	1	1	0	0	3	7	10
Sept.	3	6	1	2	0	2	1	5	10
Oct.	6	3	1	3	2	2	1	3	10
Nov.	5	3	1	1	4	2	4	4	6
Dec.	8	5	5	0	0	0	2	4	7
Year	85	56	14	11	10	11	18	58	102

NAOS.
Lat. 8° 57′. Long. —79° 31′.
Height 46 ft.
4 Years, 1881–85. Hours 7, 11 : 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	14	2	1	1	1	0	4	8	0
Feb.	12	2	1	1	0	0	1	11	0
March	11	3	1	2	1	0	1	12	0
April	9	2	1	2	1	0	1	12	2
May	7	2	2	3	1	1	1	12	2
June	8	2	2	3	2	1	4	8	0
July	8	2	1	1	2	0	9	8	0
Aug.	10	2	1	1	2	1	6	8	0
Sept.	9	2	2	2	2	1	6	6	0
Oct.	8	2	2	4	5	2	3	5	0
Nov.	7	1	2	2	4	2	5	7	0
Dec.	9	2	1	1	1	0	7	10	0
Year	112	24	17	23	22	8	48	107	4

MAZATLAN.
Lat. 23° 11′. Long. —106° 17′.
Height 249 ft.
$6\frac{1}{2}$ Years, 1881–87. Hours 5 : 3.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	8	6	2	0	0	1	9	...
Feb.	2	7	8	2	0	0	0	9	...
March	2	6	8	3	0	1	0	11	...
April	1	6	10	2	0	1	2	8	...
May	2	8	14	3	0	0	1	3	...
June	2	6	10	6	1	1	1	3	...
July	2	7	9	5	1	1	2	4	...
Aug.	3	9	9	5	1	1	0	3	...
Sept.	3	11	8	5	0	0	1	2	...
Oct.	4	12	10	2	0	1	0	2	...
Nov.	3	12	7	1	0	0	1	6	...
Dec.	2	11	8	2	0	0	1	7	...
Year	31	103	107	38	3	6	10	67	...

SAN JOSÉ.
Lat. 9° 56′. Long. —86° 0′.
Height 3756 ft.
11 Years, 1868–78. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	21	4	1	1	1	0	1	1
Feb.	1	22	2	1	0	0	0	1	1
March	2	22	2	1	1	1	0	1	1
April	2	19	4	1	0	0	0	2	2
May	3	14	2	1	1	0	1	4	5
June	1	12	2	2	2	1	1	3	6
July	1	17	2	2	1	1	0	3	4
Aug.	3	12	3	0	2	1	1	2	7
Sept.	1	10	3	2	1	1	3	4	5
Oct.	1	7	3	1	1	3	3	7	5
Nov.	1	16	4	2	1	0	0	2	4
Dec.	2	17	4	2	1	0	0	1	4
Year	19	189	35	16	12	9	9	31	45

HEREDIA.
Lat. 9° 59′. Long. —84° 9′.
Height 3776 ft.
(?) Years. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	23	7	0	0	0	0	1	...
Feb.	0	18	9	1	0	0	0	0	...
March	0	10	17	2	1	1	0	0	...
April	1	14	11	1	0	1	2	0	...
May	1	8	5	3	0	5	6	3	...
June	1	1	3	10	1	4	7	3	...
July	0	3	2	9	3	5	7	2	...
Aug.	1	4	4	7	3	6	4	2	...
Sept.	1	2	4	5	3	8	5	2	...
Oct.	0	2	3	2	3	6	9	6	...
Nov.	0	5	12	2	1	3	6	1	...
Dec.	1	16	9	1	0	1	3	0	...
Year	6	106	86	43	15	40	49	20	...

BLUEFIELDS.
Lat. 12° 8′. Long. —83° 43′.
Height 20 ft.
3 Years, 1884–86. Hour $6\frac{1}{2}$:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	8	1	0	0	0	0	14	0
Feb.	8	3	0	1	0	0	1	14	1
March	4	16	0	1	1	2	0	6	1
April	1	8	2	1	0	0	0	18	0
May	3	4	1	2	0	1	1	14	5
June	6	5	0	1	1	1	2	14	0
July	3	9	1	1	0	7	3	7	0
Aug.	4	7	0	0	0	6	2	12	0
Sept.	5	8	2	0	0	0	2	12	1
Oct.	7	3	0	0	1	4	3	13	0
Nov.	9	1	0	0	0	0	2	17	1
Dec.	13	3	0	0	0	0	1	14	0
Year	71	75	7	7	3	21	17	155	9

RIVAS.
Lat. 11° 26′. Long. —85° 47′.
Height 120 ft.
6 Years, 1881–86. Hour 6:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	27	4	0	0	0	0	0	0
Feb.	0	20	8	0	0	0	0	0	0
March	0	22	8	0	1	0	0	0	0
April	0	19	6	3	1	0	0	1	0
May	2	14	6	3	1	2	1	2	0
June	1	19	3	3	2	1	0	1	0
July	1	24	3	2	0	1	0	0	0
Aug.	0	23	3	2	0	2	1	0	0
Sept.	1	11	3	5	1	3	1	3	2
Oct.	2	9	3	4	1	3	2	4	3
Nov.	0	19	5	1	0	1	0	2	2
Dec.	0	28	2	1	0	0	0	0	0
Year	7	235	54	24	7	13	5	13	7

PUERTO BERRIO.
Lat. 6° 32′. Long. —74° 28′.
Height 542 ft.
4 Years, 1881–84. Hour 7 :

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	0	0	4	0	0	1	23
Feb.	4	0	1	1	2	0	0	1	19
March	8	1	0	1	4	0	0	1	16
April	3	1	0	1	2	0	0	1	22
May	3	0	1	0	4	0	0	0	23
June	3	0	1	1	7	0	0	0	18
July	3	1	0	0	9	0	0	0	18
Aug.	4	1	1	1	8	0	0	0	16
Sept.	3	1	0	2	7	1	0	1	15
Oct.	2	1	0	1	9	1	0	0	17
Nov.	5	0	1	0	4	1	0	0	19
Dec.	2	0	0	1	2	0	1	0	25
Year	42	7	5	9	62	3	1	5	231

Month.	BUENAVENTURA. Lat. 3° 50′. Long. —76° 55′. Height 18 ft. 1 Year, 1882–83. Hour 7:									BOGATA. Lat. 4° 36′. Long. —74° 14′. Height 8655 ft. 5 Years, 1881-84, 86-87. Hour 7:									GEORGE TOWN. Lat. 6° 50′. Long. —58° 8′. Height 10 ft. Hours (?) 5 Years, 1850–51, 1854–56.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	6	4	7	0	1	11	2	4	2	0	3	2	1	2	15	0	11	19	0	0	0	0	0	1
Feb.	1	0	0	2	5	4	0	0	16	3	2	1	2	2	3	1	1	13	0	15	13	0	0	0	0	0	0
March	4	2	0	2	14	2	0	0	7	3	2	1	1	3	4	1	2	14	0	17	14	0	0	0	0	0	0
April	9	2	0	0	0	0	0	2	17	3	0	1	2	3	4	2	3	12	0	11	18	1	0	0	0	0	0
May	0	1	0	1	8	1	0	0	20	3	2	2	1	3	3	2	1	14	0	9	18	4	0	0	0	0	0
June	1	0	0	1	9	0	0	0	19	2	3	0	1	3	3	2	1	15	0	6	22	2	0	0	0	0	0
July	3	1	0	1	9	2	0	0	15	2	2	1	2	7	2	2	2	11	0	8	19	4	0	0	0	0	0
Aug.	0	1	0	1	8	1	0	0	20	3	1	1	2	4	2	2	1	15	0	7	21	0	0	0	1	0	2
Sept.	11	1	0	0	0	1	0	5	12	3	1	2	3	4	2	3	4	8	0	9	20	1	0	0	0	0	0
Oct.	0	0	2	2	8	7	2	0	10	1	2	1	1	2	2	1	1	20	0	11	19	1	0	0	0	0	0
Nov.	1	1	0	3	9	11	4	1	0	1	2	1	1	1	2	3	1	18	0	9	20	1	0	0	0	0	0
Dec.	2	2	1	3	6	7	6	0	4	1	1	1	1	2	2	1	1	21	0	11	19	1	0	0	0	0	0
Year	33	11	4	22	80	43	12	9	151	27	22	14	17	37	31	21	20	176	0	124	222	15	0	0	1	0	3

Month.	CATHERINA SOPHIA. Lat. 5° 48′. Long. —56° 47′. Height 50 ft. 4 Years, 1856–59. Hours 7: 2, 9.									CAYENNE. Lat. 4° 56′. Long. —55° 39′. Hours generally mean of day. 7 Years, 1846–52. Height 7 ft.									MARANHAO. Lat. —2° 30′. Long. —44° 0′. Height 14 ft. 9 Months, 1886–87. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	16	7	5	0	0	1	0	...	1	23	5	0	0	0	0	0	2	...	...	...	...	...	...	...	...	...
Feb.	1	18	6	3	0	0	0	0	...	1	23	2	0	0	0	0	0	2	1	8	12	1	0	0	0	0	6
March	2	21	3	4	0	1	0	0	...	2	24	3	0	0	0	0	0	2	10	10	3	0	0	1	0	1	6
April	2	17	6	4	1	0	0	0	...	1	19	5	2	0	0	0	0	3	1	10	8	1	0	1	0	2	7
May	1	12	7	7	2	1	0	1	...	1	11	13	1	0	0	0	0	5	1	9	10	4	0	1	2	1	3
June	1	10	6	9	2	1	0	1	...	0	8	18	2	0	0	0	0	2	0	10	11	5	0	2	0	0	2
July	2	9	5	8	5	1	0	1	...	0	4	21	3	0	0	0	0	3	0	10	14	4	0	1	0	0	2
Aug.	1	10	6	9	2	2	0	1	...	0	2	24	4	0	0	0	0	1	0	13	15	2	1	0	0	0	0
Sept.	1	11	5	8	2	1	0	2	...	0	4	25	1	0	0	0	0	0	...	...	...	...	...	...	...	...	...
Oct.	1	13	6	7	3	0	0	1	...	1	7	21	1	0	0	0	0	1	...	...	...	...	...	...	...	...	...
Nov.	1	12	5	7	4	1	0	0	...	1	10	17	1	0	0	0	0	1	0	15	15	0	0	0	0	0	0
Dec.	1	12	7	9	2	0	0	0	...	0	20	9	0	0	0	0	0	2	0	14	16	1	0	0	0	0	0
Year	16	161	69	80	23	8	1	7	...	8	155	163	15	0	0	0	0	24	...	...	...	...	...	...	...	...	...

Month.	PERNAMBUCO. Lat. —8° 4′. Long. —34° 52′. Height 11 ft. 8 Years, 1876–84. Hours S.-R., N.: S.-S.									SAN BENTO DAS LAGOS. Lat. —12° 13′. Long. —38° 40′. Height 98 ft. 6 Years, 1879–84. Hours 6: 2, 8.									COLONIA ISABEL. Lat. —8° 45′. Long. —35° 42′. Height 751 ft. 7 Months, 1876–77. Hours 6, 10: 2, 6.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	9	18	3	1	0	0	0	...	5	2	2	12	5	0	0	5	...	5	7	9	3	3	1	1	2	...
Feb.	0	0	6	11	11	0	0	0	...	4	3	2	9	4	1	0	5	...	5	3	6	4	7	1	1	1	...
March	0	1	14	14	2	0	0	0	...	5	2	3	11	4	0	0	6	...	...	...	...	...	...	...	...	...	...
April	1	0	3	15	11	0	0	0	...	4	2	1	9	8	0	0	6	...	...	...	...	...	...	...	...	...	...
May	0	1	1	13	16	0	0	0	...	3	1	2	5	15	0	0	5	...	...	...	...	...	...	...	...	...	...
June	0	0	6	9	14	1	0	0	...	3	0	2	7	13	1	0	4	...	...	...	...	...	...	...	...	...	...
July	0	0	2	16	13	0	0	0	...	3	1	2	7	14	1	0	3	...	...	...	...	...	...	...	...	...	...
Aug.	0	0	1	21	9	0	0	0	...	4	1	1	7	14	1	0	3	...	0	0	1	3	6	15	5	1	...
Sept.	0	6	10	10	4	0	0	0	...	5	2	2	7	9	0	0	5	...	3	3	3	3	3	8	4	3	...
Oct.	0	6	17	7	1	0	0	0	...	6	2	1	8	8	1	0	5	...	4	6	5	4	2	5	4	1	...
Nov.	1	16	12	1	0	0	0	0	...	7	2	2	7	6	1	0	5	...	6	9	8	3	1	1	0	2	...
Dec.	0	10	21	0	0	0	0	0	...	7	2	1	8	7	1	0	5	...	7	8	9	2	1	1	0	3	...
Year	2	49	111	120	82	1	0	0	...	56	20	21	97	107	7	0	57	...	...	...	...	...	...	...	...	...	...

ITABIRA DO CAMPO. Lat. —19° 40′. Long. —43° 5′. Height 2733 ft. 9 Months, 1882–83. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	1	2	23	2	0	1	0	2	...
April	...	...	...	...	...	...	...	...	...
May	0	0	23	3	2	1	2	0	...
June	0	0	24	4	1	1	0	0	...
July	0	0	27	2	0	2	0	0	...
Aug.	0	0	25	2	1	2	0	1	...
Sept.	0	0	20	0	0	7	0	3	...
Oct.	1	3	25	1	0	0	1	0	...
Nov.	1	0	22	1	0	2	0	4	...
Dec.	3	0	18	3	1	2	1	3	...
Year	...	...	...	...	...	...	...	...	...

RIO JANEIRO. Lat. —22° 57′. Long. —43° 7′. Height 224 ft. 2 Years, 1881–83. Hours 4, 7, 10 : 1, 7, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	1	5	6	2	1	8	2
Feb.	3	2	0	6	6	3	1	7	0
March	3	3	2	6	7	2	1	7	0
April	3	3	1	5	4	3	1	10	0
May	3	3	1	5	4	2	2	10	1
June	3	4	2	3	3	1	4	9	1
July	3	4	1	4	3	2	1	11	2
Aug.	2	3	2	5	5	2	1	10	1
Sept.	1	2	1	6	6	2	1	9	2
Oct.	1	4	1	6	7	2	1	7	2
Nov.	1	4	1	7	9	2	1	4	1
Dec.	2	4	1	5	7	2	1	7	2
Year	28	39	14	63	67	25	16	99	14

SANTA CRUZ. Lat. —22° 56′. Long. —41° 39′. Height 85 ft. 1 Year, 1886–87. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	14	1	2	6	2	0	0	5
Feb.	0	11	1	3	3	0	0	1	9
March	1	9	7	4	1	1	1	4	3
April	9	6	2	1	2	1	0	3	6
May	7	10	0	1	2	3	0	5	3
June	11	11	0	0	1	3	0	3	1
July	12	10	2	0	1	1	0	2	3
Aug.	18	7	0	1	2	2	0	1	0
Sept.	3	1	0	2	8	5	0	0	11
Oct.	7	8	0	2	3	3	0	1	7
Nov.	3	5	1	4	8	3	0	0	6
Dec.	6	3	1	2	6	2	0	0	11
Year	78	95	15	22	43	26	1	20	65

SAN PAULO. Lat. —23° 33′. Long. —46° 37′. Height 2393 ft. 5 Years, 1879–83. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	1	2	0	0	0	3	22
Feb.	0	1	1	3	1	0	0	3	19
March	1	2	2	2	1	1	0	1	21
April	0	2	1	2	1	1	0	1	22
May	1	2	1	1	0	0	0	1	25
June	0	2	1	1	1	0	0	1	24
July	1	2	0	1	1	1	1	0	24
Aug.	0	2	1	4	1	1	1	0	21
Sept.	0	2	2	5	1	1	0	0	19
Oct.	1	2	1	5	1	1	0	2	18
Nov.	0	1	2	4	1	1	0	2	19
Dec.	0	1	2	3	1	0	0	3	21
Year	5	21	15	33	10	7	2	17	255

RIO GRANDE DO SUL. Lat. —32° 0′. Long. —52° 15′. Height 54 ft. 1½ Years, 1882–83. Hours (?)

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	6	4	7	2	1	1	1
Feb.	3	10	5	1	4	3	1	1	0
March	1	4	5	3	3	7	6	1	1
April	3	6	4	2	4	6	3	1	1
May	3	6	4	2	3	6	4	2	1
June	5	8	5	1	2	5	3	1	0
July	4	9	3	2	2	5	4	2	0
Aug.	3	10	5	2	5	4	1	1	0
Sept.	1	8	6	2	6	4	1	1	1
Oct.	1	11	6	3	5	4	1	0	0
Nov.	3	10	6	2	5	3	1	0	0
Dec.	2	10	7	2	4	5	1	0	0
Year	31	99	62	26	50	54	27	11	5

COLONIA, MONTE VIDEO. Lat. —34° 50′. Long. —58° 37′. Height 109 ft. 2 Years, 1883–84. Hours 7 : 2, 7.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	5	9	2	3	0	3	0
Feb.	1	6	2	7	4	4	1	2	1
March	2	10	2	6	3	3	1	3	1
April	1	3	3	6	2	7	3	3	2
May	2	3	2	4	3	8	2	5	2
June	4	5	1	3	2	6	3	4	2
July	4	8	1	2	1	8	2	3	2
Aug.	3	11	2	5	2	4	0	2	2
Sept.	1	9	3	7	3	5	0	1	1
Oct.	1	8	3	5	3	5	2	2	2
Nov.	1	7	3	5	2	7	2	2	1
Dec.	2	8	4	5	3	6	1	2	0
Year	24	85	31	64	30	66	17	32	16

ASSUNCION. Lat. —25° 16′. Long. —57° 40′. Height 322 ft. 11 Months, 1854. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	4	7	7	5	1	0	1	4
Feb.	...	...	...	...	...	...	...	...	...
March	5	7	3	8	4	1	1	2	0
April	5	5	3	6	6	2	1	2	0
May	6	5	9	7	3	1	0	0	0
June	4	4	15	3	2	0	1	1	0
July	2	4	12	5	5	1	2	0	0
Aug.	3	5	7	7	3	1	3	0	2
Sept.	2	6	10	2	6	2	0	0	2
Oct.	4	8	7	4	3	4	0	0	1
Nov.	7	6	5	4	4	0	2	2	0
Dec.	4	8	3	5	4	1	1	2	3
Year	...	...	...	...	...	...	...	...	...

CORRIENTES. Lat. —27° 28′. Long. —58° 49′. Height 280 ft. 8 Years, 1873–80. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	3	4	2	13	0	1	0	1
Feb.	9	4	4	2	9	0	0	0	0
March	9	3	4	3	11	0	0	0	1
April	7	2	4	3	13	0	0	0	1
May	8	4	4	2	12	0	0	0	1
June	11	3	3	1	12	0	0	0	0
July	12	2	3	2	11	1	0	0	0
Aug.	13	3	2	1	12	0	0	0	0
Sept.	8	3	3	2	13	1	0	0	0
Oct.	7	2	4	3	15	0	0	0	0
Nov.	6	3	4	3	14	0	0	0	0
Dec.	9	3	4	3	10	1	0	0	1
Year	106	35	43	27	145	3	1	0	5

GOYA. Lat. —29° 91′. Long. —59° 15′. Height 209 ft. 9 Years, 1876–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	4	7	6	2	1	1	...
Feb.	3	3	4	9	6	2	0	1	...
March	6	3	4	9	4	2	1	2	...
April	5	4	3	8	5	3	1	1	...
May	7	6	2	5	6	3	1	1	...
June	7	6	2	2	8	3	1	1	...
July	7	6	3	5	7	2	1	0	...
Aug.	7	6	3	5	5	3	1	1	...
Sept.	2	6	4	9	5	3	0	1	...
Oct.	4	4	5	9	5	2	1	1	...
Nov.	3	7	4	8	5	1	1	1	...
Dec.	6	5	4	7	6	1	1	1	...
Year	62	61	42	83	68	27	10	12	...

CONCORDIA. Lat. —31° 25′. Long. —58° 4′. Height 200 ft. 3 Years, 1876–78. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	6	7	2	4	2	1	...
Feb.	2	6	6	7	2	2	2	1	...
March	7	8	5	5	2	2	2	0	...
April	4	8	6	3	2	5	2	0	...
May	7	8	3	2	2	4	4	1	...
June	6	6	4	1	2	4	5	2	...
July	10	6	4	3	2	3	2	1	...
Aug.	9	5	4	2	3	4	3	1	...
Sept.	9	5	3	2	3	4	3	1	...
Oct.	6	8	4	4	3	3	2	1	...
Nov.	4	7	5	5	2	4	2	1	...
Dec.	5	7	4	3	3	5	3	1	...
Year	71	81	54	44	28	44	32	11	...

TUCUMAN. Lat. —26° 51′. Long. —65° 12′. Height 1522 ft. Hours 7 : 2, 9. 8 Years, 1873–77, 79–86.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	3	2	3	7	2	4	2	2
Feb.	5	4	3	2	4	4	3	2	1
March	5	3	2	3	4	5	4	4	1
April	4	2	2	1	5	7	5	3	1
May	2	1	2	3	6	8	5	2	2
June	2	2	4	2	6	9	3	1	1
July	2	2	2	3	9	8	2	1	2
Aug.	2	3	4	3	9	4	3	1	2
Sept.	3	1	3	4	8	5	3	1	2
Oct.	2	2	3	5	8	5	3	2	1
Nov.	2	2	3	3	7	6	4	2	1
Dec.	3	2	2	3	7	6	4	2	2
Year	38	27	32	35	80	69	43	23	18

SAN LUIS. Lat. —33° 19′. Long. —66° 20′. Height 2490 ft. 4 Years, 1874–77. Hours 7 : 2, 9.

Month.	N.	N.E.	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	7	3	2	1	1	2	10
Feb.	6	2	5	3	0	0	1	3	8
March	2	2	6	5	1	0	1	3	10
April	2	2	6	4	1	0	1	4	10
May	6	2	4	3	2	0	0	6	8
June	4	2	3	2	1	1	0	3	14
July	3	3	6	2	1	1	1	3	11
Aug.	4	2	5	2	1	0	2	3	12
Sept.	2	1	5	4	1	1	1	3	12
Oct.	4	1	8	7	1	1	1	2	6
Nov.	4	1	6	7	1	1	1	1	8
Dec.	4	3	5	6	2	1	1	3	6
Year	43	24	66	48	14	7	11	36	116

PARANA. Lat. —31° 44′. Long. —61° 1′. Height 256 ft. 8 Years, 1875–82. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	2	6	2	7	1	4	2	0
Feb.	7	3	5	3	6	1	2	1	0
March	8	2	9	3	6	2	1	0	0
April	7	3	6	2	7	1	1	1	2
May	10	2	4	2	7	1	2	1	2
June	8	2	4	2	8	1	2	1	2
July	7	3	8	3	7	1	1	0	1
Aug.	7	3	7	3	7	1	1	1	1
Sept.	4	3	9	4	6	0	1	0	3
Oct.	5	3	11	4	7	0	1	0	0
Nov.	9	3	6	5	4	1	1	1	0
Dec.	9	3	5	3	6	1	3	1	0
Year	88	32	80	36	78	11	20	9	11

VILLA HERNANDARIA. Lat. —31° 15′. Long. —59° 40′. Height 190 ft. 8 Years, 1877–84. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	8	3	5	6	1	1	0
Feb.	3	1	8	2	7	6	1	0	0
March	4	1	9	4	6	5	1	1	0
April	4	2	8	3	6	6	1	0	0
May	5	2	8	3	5	6	1	1	0
June	5	1	7	3	5	6	1	1	1
July	6	2	7	3	4	6	1	1	1
Aug.	5	2	8	3	5	6	1	1	0
Sept.	4	2	8	3	7	6	0	0	0
Oct.	4	2	9	3	6	6	1	0	0
Nov.	5	1	9	2	6	6	1	0	0
Dec.	7	1	9	3	5	4	1	0	1
Year	57	19	98	35	67	69	11	6	3

ROSARIO. Lat. —32° 57′. Long. —60° 38′. Height 128 ft. 6 Years, 1875–80. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	7	5	5	2	1	1	3
Feb.	5	4	5	4	3	1	0	2	4
March	6	4	6	6	4	1	0	0	4
April	6	3	4	3	6	2	1	1	4
May	8	3	3	2	6	2	1	2	4
June	5	4	3	3	6	4	0	3	2
July	6	4	3	4	6	3	1	2	2
Aug.	6	4	4	5	6	2	1	1	2
Sept.	3	4	6	6	5	3	1	1	1
Oct.	3	5	4	7	6	3	0	1	2
Nov.	3	4	6	6	5	2	1	1	2
Dec.	5	4	6	3	5	3	1	2	2
Year	59	47	57	54	63	28	8	17	32

BUENOS AYRES. Lat. —34° 39′. Long. —58° 23′. Height 72 ft. 20 Years, 1857–76. Hours 7 ; 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	5	7	4	3	2	1	2	...
Feb.	4	4	7	4	3	3	1	2	...
March	6	5	5	4	4	3	2	2	...
April	7	4	3	3	3	4	3	3	...
May	6	4	3	3	3	6	3	3	...
June	6	4	3	4	3	5	3	2	...
July	5	4	4	3	4	5	3	3	...
Aug.	5	4	4	5	4	4	2	3	...
Sept.	5	4	5	5	4	4	1	2	...
Oct.	4	4	7	6	4	4	1	1	...
Nov.	5	5	6	4	3	4	1	2	...
Dec.	5	5	6	4	3	4	2	2	...
Year	65	52	60	49	41	48	23	27	...

TANDIL. Lat. —37° 17′. Long. —59° 0′. Height 651 ft. 6 Years, 1876–82. Hours 7 : 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	10	2	2	3	2	4	2	6	0
Feb.	9	3	2	1	2	3	2	5	1
March	9	2	3	2	2	4	4	4	1
April	5	2	2	2	5	6	3	4	1
May	7	2	2	1	7	6	2	4	0
June	5	2	1	1	4	9	4	4	0
July	7	2	1	2	5	5	3	6	0
Aug.	9	2	2	3	4	5	2	4	0
Sept.	8	2	2	2	5	6	1	3	1
Oct.	10	2	1	2	4	5	2	5	0
Nov.	8	3	1	3	2	5	3	5	0
Dec.	7	2	2	2	3	5	4	6	0
Year	94	26	21	24	45	63	32	56	4

BAHIA BLANCA. Lat. —38° 45′. Long. —62° 11′. Height 49 ft. 20 Years, 1860–79. Hours various.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	5	9	1	1	2	5	...
Feb.	5	3	5	6	2	1	1	5	...
March	7	2	4	5	2	1	2	8	...
April	7	2	2	4	2	2	3	8	...
May	7	1	2	4	2	2	3	10	...
June	6	1	1	3	2	2	3	12	...
July	6	2	1	3	2	2	4	11	...
Aug.	7	2	2	5	2	1	3	9	...
Sept.	7	3	3	6	2	1	2	6	...
Oct.	7	4	4	5	2	1	2	6	...
Nov.	6	4	4	6	2	1	2	5	...
Dec.	6	3	4	7	2	1	3	5	...
Year	76	30	37	63	23	16	30	90	...

IQUIQUE. Lat. —20° 12′. Long. —70° 11′. Height 30 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	0	0	5	22	1	1	2
Feb.	1	0	1	0	5	14	1	1	5
March	1	0	1	0	6	14	2	1	6
April	2	0	0	0	9	9	2	2	6
May	0	2	1	2	6	11	3	0	6
June	1	3	1	2	7	10	3	2	1
July	3	3	2	2	4	12	2	2	1
Aug.	2	3	2	1	2	16	3	2	0
Sept.	2	2	1	1	8	10	2	2	2
Oct.	1	1	0	1	10	15	2	0	1
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

PUNTA CALDERA. Lat. —27° 3′. Long. —70° 50′. Height 82 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	4	1	2	1	19	0	3	0
Feb.	0	5	1	2	1	16	0	3	0
March	1	7	1	3	1	16	0	2	0
April	1	5	2	5	0	14	0	3	0
May	2	7	1	7	2	8	0	4	0
June	2	9	1	6	1	8	0	3	0
July	2	9	1	4	1	11	0	3	1
Aug.	2	8	1	5	1	10	0	4	0
Sept.	2	3	1	4	1	15	0	4	0
Oct.	1	5	0	2	1	15	0	7	0
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

COPIAPO. Lat. —27° 23′. Long. —70° 7′. Height 1296 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	0	0	0	0	0	9	22
Feb.	0	0	0	0	0	0	0	6	22
March	0	0	0	0	0	0	0	5	26
April	0	0	0	0	0	0	0	5	25
May	0	0	0	0	0	0	0	6	25
June	0	0	0	0	0	0	0	1	29
July	0	0	0	0	0	0	0	8	23
Aug.	0	0	0	0	0	0	0	7	24
Sept.	0	0	0	0	0	0	0	10	20
Oct.	0	0	0	0	0	0	0	13	18
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

COQUIMBO. Lat. —29° 56′. Long. —71° 21′. Height 74 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	7	1	0	8	5	2	1
Feb.	2	2	8	1	0	6	6	2	1
March	3	2	10	2	0	5	7	2	0
April	5	2	6	2	0	6	4	2	3
May	4	1	9	3	2	4	6	1	1
June	2	1	11	3	1	5	5	1	1
July	3	2	10	2	1	6	5	1	1
Aug.	2	1	9	2	1	1	10	3	2
Sept.	1	1	8	4	1	4	8	3	0
Oct.	3	2	6	2	0	4	11	1	2
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

SANTIAGO DE CHILE. Lat. —33° 27′. Long. —70° 41′. Height 1703 ft. 21 Years, 1860–81. Hours 7: 2, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	0	3	1	0	13	2	0	12
Feb.	0	0	3	0	1	10	3	0	11
March	0	0	3	0	1	10	1	0	16
April	0	1	3	1	0	8	2	0	15
May	1	1	4	0	0	5	1	1	18
June	1	0	3	1	1	4	1	1	18
July	1	1	3	1	1	4	1	1	18
Aug.	0	1	3	1	1	7	1	1	16
Sept.	0	0	3	1	1	10	2	0	13
Oct.	0	0	3	1	1	11	3	1	11
Nov.	0	0	3	0	1	11	3	0	12
Dec.	0	0	3	1	0	12	3	0	12
Year	3	4	37	8	8	105	23	5	172

VALPARAISO. Lat. —33° 2′. Long. —71° 39′. Height 0 ft. 3 Years, 1853–55. Hours $9\frac{1}{2}$: $3\frac{1}{2}$.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	0	0	6	9	3	3	5
Feb.	3	2	0	1	7	3	2	1	9
March	5	2	0	2	5	3	2	2	10
April	8	2	1	1	4	4	1	3	6
May	9	3	1	2	3	2	1	1	9
June	7	3	1	1	2	2	1	2	11
July	7	3	1	3	4	3	1	1	8
Aug.	10	3	1	2	4	3	0	3	5
Sept.	6	2	3	1	3	3	2	4	6
Oct.	6	4	2	1	7	7	1	2	1
Nov.	3	2	2	1	10	6	1	2	3
Dec.	5	2	1	0	8	7	1	2	5
Year	73	29	13	15	63	52	16	26	78

VALPARAISO. Lat. —33° 2′. Long. —71° 39′. Height 133 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	1	3	9	3	0	13
Feb.	1	1	0	0	2	4	4	1	15
March	1	0	0	0	2	5	4	1	18
April	3	3	0	2	3	8	2	1	8
May	3	3	1	2	5	5	1	1	10
June	3	1	1	1	7	4	3	1	9
July	2	3	1	2	5	2	3	0	13
Aug.	3	0	2	0	4	3	2	2	17
Sept.	2	0	0	0	5	4	1	1	17
Oct.	1	1	0	0	4	6	1	0	18
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

QUIRIQUINA. Lat. —36° 37′. Long. —73° 3′. Height 190 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	0	1	2	5	15	3	4	0
Feb.	1	0	1	1	4	8	4	5	4
March	4	0	1	1	7	6	5	5	2
April	1	0	2	1	11	6	6	2	1
May	4	1	2	4	7	2	3	6	2
June	4	1	1	4	8	4	3	5	0
July	2	1	0	7	5	3	2	10	1
Aug.	5	0	1	5	5	3	3	8	1
Sept.	3	0	2	3	5	4	8	3	2
Oct.	0	0	0	4	8	8	5	4	2
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

PUNTA NIEBLA. Lat. —39° 53′. Long. —73° 25′. Height 98 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	0	13	0	2	1	5	7	1
Feb.	1	0	15	0	1	1	2	6	2
March	4	0	15	0	1	0	4	6	1
April	6	0	17	0	1	0	3	2	1
May	5	0	18	0	0	1	0	6	1
June	3	0	23	0	0	0	0	4	0
July	8	1	13	0	0	2	2	6	1
Aug.	6	0	3	9	1	7	2	2	1
Sept.	4	1	1	9	2	8	1	3	1
Oct.	2	1	0	9	5	9	1	3	1
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

PUNTA CORONA. Lat. —41° 47′. Long. —73° 53′. Height 173 ft. 10 Months, 1886. Hours $7\frac{1}{2}$: $1\frac{1}{2}$, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	0	0	0	1	9	6	11	...
Feb.	3	3	1	1	1	11	2	6	...
March	2	3	0	2	2	6	3	13	...
April	2	2	2	7	3	6	1	7	...
May	5	3	0	3	2	7	1	11	...
June	7	4	2	3	1	7	1	5	...
July	8	5	1	1	2	4	3	7	...
Aug.	6	1	0	2	2	5	1	14	...
Sept.	4	2	1	3	1	6	3	10	...
Oct.	2	0	1	0	1	14	1	12	...
Nov.	...	...	...	...	...	...	...	...	...
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

ANCUD. Lat. —41° 51′. Long. —74° 0′. Height 66 ft. 2 Years, 1866-68. Hours 8, N.: 4, 10.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	0	0	2	13	3	7	1
Feb.	3	0	0	0	7	8	4	5	1
March	6	0	0	0	4	6	10	3	2
April	6	2	2	1	2	4	4	6	3
May	11	5	3	2	1	0	3	6	0
June	5	2	1	1	2	2	3	12	2
July	5	2	0	4	2	4	3	9	2
Aug.	6	5	0	1	1	1	5	9	3
Sept.	4	1	0	4	6	3	4	3	5
Oct.	5	1	0	1	2	9	8	2	3
Nov.	6	0	0	0	1	7	4	6	6
Dec.	6	1	0	0	0	8	2	9	5
Year	67	20	6	14	30	65	53	77	33

USHUAIA. Lat. —54° 53′. Long. —68° 10′. Height 98 ft. 9 Years, 1874-82. Hours 7: 2, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	1	0	0	6	15	1	3
Feb.	3	1	1	0	0	4	13	1	5
March	7	1	1	1	1	3	9	1	7
April	4	1	3	1	1	5	7	1	7
May	5	0	2	2	1	4	5	2	10
June	5	1	1	1	2	5	7	1	7
July	3	0	3	1	1	4	7	1	11
Aug.	2	2	2	2	1	11	4	2	5
Sept.	2	2	4	1	1	3	6	3	8
Oct.	4	1	4	1	0	5	10	2	4
Nov.	4	1	4	1	1	4	10	2	3
Dec.	2	1	3	1	1	5	12	1	5
Year	45	12	29	12	10	59	105	18	75

STANLEY. Lat. —51° 41′. Long. —57° 51′. Height 22 ft. 1 Year, 1875. Hour 9:

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	0	0	0	6	8	10	5	0
Feb.	3	0	0	0	6	3	9	7	0
March	3	0	1	0	0	7	13	7	0
April	2	0	1	0	2	4	17	2	2
May	5	2	6	0	0	0	14	4	0
June	2	0	3	2	5	0	14	3	1
July	4	0	0	1	5	4	14	1	2
Aug.	2	0	0	0	4	1	16	5	3
Sept.	2	0	0	2	1	4	17	3	1
Oct.	3	0	0	0	7	8	11	1	1
Nov.	1	1	1	1	12	5	9	0	0
Dec.	4	3	3	3	5	4	8	1	0
Year	33	6	15	9	53	48	152	39	10

ORANGE BAY. Lat. —55° 31′. Long. —68° 5′. Height 39 ft. 1 Year, 1882-83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W	N.W	CA.
Jan.	1	1	1	0	2	13	9	3	1
Feb.	1	1	0	0	1	9	10	2	4
March	3	2	1	1	1	4	8	7	4
April	3	2	0	0	1	5	8	5	6
May	5	5	1	0	0	5	7	6	2
June	1	2	3	2	1	6	7	4	4
July	2	3	2	0	1	5	9	6	3
Aug.	5	3	1	1	1	3	8	7	2
Sept.	2	6	2	0	0	9	5	3	3
Oct.	1	0	0	0	1	3	10	15	1
Nov.	1	1	0	1	0	5	14	6	2
Dec.	1	0	0	0	2	10	11	3	4
Year	26	26	11	5	11	77	106	67	36

SOUTH GEORGIA. Lat. —54° 31′. Long. —36° 5′. Height 39 ft. 1 Year, 1882-83. Hourly.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	2	3	3	1	6	9	4	...
Feb.	2	2	1	1	3	6	8	5	...
March	3	1	2	2	2	4	10	7	...
April	5	1	1	3	1	5	11	3	...
May	4	2	1	1	1	8	10	4	...
June	3	1	4	2	1	5	10	4	...
July	3	1	0	2	2	7	11	5	...
Aug.	4	3	1	2	1	5	11	4	...
Sept.	4	2	1	1	3	4	9	6	...
Oct.	5	2	1	2	3	5	7	6	...
Nov.	6	3	3	1	1	4	7	5	...
Dec.	4	1	2	1	1	5	11	6	...
Year	46	21	20	21	20	64	114	59	...

NORTH ATLANTIC. Lat. 12° 30′. Long. —22° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881-86. Hour*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	25	4	1	0	0	0	0	0
Feb.	3	20	5	0	0	0	0	0	0
March	2	26	3	0	0	0	0	0	0
April	1	26	3	0	0	0	0	0	0
May	1	27	2	0	0	1	0	0	0
June	1	26	2	0	0	1	0	0	0
July	2	23	5	0	1	0	0	0	0
Aug.	4	13	2	1	2	1	4	3	1
Sept.	3	13	5	2	2	0	1	3	1
Oct.	1	23	4	1	2	0	0	0	0
Nov.	2	19	8	1	0	0	0	0	0
Dec.	2	22	7	0	0	0	0	0	0
Year	23	263	50	6	7	3	5	6	2

NORTH ATLANTIC. Lat. 12° 30′. Long. —32° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881-86. Hour.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	18	11	1	0	0	0	0	0
Feb.	1	17	10	0	0	0	0	0	0
March	0	21	10	0	0	0	0	0	0
April	1	18	11	0	0	0	0	0	0
May	0	25	6	0	0	0	0	0	0
June	0	20	10	0	0	0	0	0	0
July	0	19	11	0	0	0	1	0	0
Aug.	4	16	6	1	1	0	1	1	1
Sept.	2	12	10	2	1	1	1	0	1
Oct.	1	12	13	1	2	0	1	0	1
Nov.	0	8	18	4	0	0	0	0	0
Dec.	1	6	20	2	1	0	1	0	0
Year	11	192	136	11	5	1	5	1	3

NORTH ATLANTIC. Lat. 12° 30′. Long. —42° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881-86. Hour.*

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	11	19	1	0	0	0	0	0
Feb.	0	7	21	0	0	0	0	0	0
March	0	11	19	1	0	0	0	0	0
April	1	10	18	1	0	0	0	0	0
May	0	13	17	1	0	0	0	0	0
June	0	5	25	0	0	0	0	0	0
July	0	4	26	1	0	0	0	0	0
Aug.	1	12	15	1	1	0	0	0	1
Sept.	1	5	18	4	2	0	0	0	0
Oct.	1	6	17	5	1	0	0	1	0
Nov.	0	4	22	3	1	0	0	0	0
Dec.	1	7	22	1	0	0	0	0	0
Year	5	95	239	19	5	0	0	1	1

* About 1 P.M. Greenwich Mean Time.

NORTH ATLANTIC. Lat. 12° 30′. Long. —52° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	0	8	22	1	0	0	0	0	...
Feb.	1	5	21	1	0	0	0	0	...
March	1	8	18	4	0	0	0	0	...
April	1	5	16	7	1	0	0	0	...
May	0	3	24	4	0	0	0	0	...
June	0	3	25	2	0	0	0	0	...
July	0	3	22	6	0	0	0	0	...
Aug.	0	3	20	6	2	0	0	0	...
Sept.	1	3	17	7	2	0	0	0	...
Oct.	1	3	15	9	2	0	1	0	...
Nov.	0	1	20	8	1	0	0	0	...
Dec.	1	8	20	2	0	0	0	0	...
Year	6	53	240	57	8	0	1	0	...

NORTH ATLANTIC. Lat. 22° 30′. Long. —22° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	14	11	2	0	0	1	1	0
Feb.	4	11	9	2	0	0	1	1	0
March	5	20	4	0	0	1	1	0	0
April	4	19	4	1	0	0	1	1	0
May	4	19	7	0	1	0	0	0	0
June	1	22	6	0	1	0	0	0	0
July	3	21	7	0	0	0	0	0	0
Aug.	1	23	7	0	0	0	0	0	0
Sept.	1	17	10	1	1	0	0	0	0
Oct.	0	17	9	1	1	1	0	1	1
Nov.	3	16	7	1	1	1	0	1	0
Dec.	2	8	14	3	1	0	1	1	1
Year	30	207	95	11	6	3	5	6	2

NORTH ATLANTIC. Lat. 22° 30′. Long. —32° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	6	13	6	1	0	1	2	0
Feb.	2	8	9	4	1	1	0	2	1
March	3	12	10	3	2	1	0	0	0
April	3	10	11	2	1	1	1	1	0
May	2	17	10	1	1	0	0	0	0
June	1	12	13	1	1	1	0	1	0
July	1	17	13	0	0	0	0	0	0
Aug.	1	19	11	0	0	0	0	0	0
Sept.	0	9	17	3	1	0	0	0	0
Oct.	0	9	14	4	1	2	0	1	0
Nov.	4	8	14	2	0	1	0	1	0
Dec.	3	9	13	3	1	1	0	1	0
Year	22	136	148	29	10	8	2	9	1

NORTH ATLANTIC. Lat. 22° 30′. Long. —42° 30. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	9	12	5	1	1	0	1	0
Feb.	2	9	8	4	3	0	1	1	0
March	3	8	10	5	2	1	1	1	0
April	2	4	11	7	3	1	1	1	0
May	1	6	15	7	1	0	1	0	0
June	1	4	14	7	2	1	0	1	0
July	0	3	22	5	0	0	0	1	0
Aug.	1	5	23	2	0	0	0	0	0
Sept.	1	2	20	6	1	0	0	0	0
Oct.	2	7	11	6	2	1	0	1	1
Nov.	1	10	13	4	2	0	0	0	0
Dec.	3	8	12	6	1	0	0	1	0
Year	19	75	171	64	18	5	4	8	1

NORTH ATLANTIC. Lat. 22° 30′. Long. —52° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	8	14	3	2	0	1	0	0
Feb.	3	7	9	3	2	2	0	2	0
March	2	4	8	5	7	1	1	2	1
April	2	5	7	7	3	2	2	1	1
May	2	4	8	10	3	1	1	1	1
June	1	1	8	15	2	1	0	1	1
July	0	1	11	13	4	1	0	0	1
Aug.	1	3	10	12	4	1	0	0	0
Sept.	1	5	10	9	2	1	1	1	0
Oct.	2	6	10	8	2	1	0	1	1
Nov.	3	8	11	4	1	2	0	1	0
Dec.	4	8	12	5	1	0	0	1	0
Year	24	60	118	94	33	13	6	11	6

NORTH ATLANTIC. Lat. 22° 30′. Long. —62° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	9	13	5	2	0	0	1	0
Feb.	1	10	8	4	1	2	1	0	1
March	2	8	8	3	4	2	2	2	0
April	2	5	9	6	3	2	2	1	0
May	1	4	8	12	3	1	1	0	1
June	1	2	12	10	3	2	0	0	0
July	0	1	15	12	2	0	0	0	1
Aug.	0	1	16	9	3	1	0	0	1
Sept.	1	3	12	10	2	1	0	1	0
Oct.	2	6	9	8	2	1	1	1	1
Nov.	2	8	11	5	1	1	0	1	1
Dec.	2	8	13	4	1	1	1	1	0
Year	15	65	134	88	27	14	8	8	6

NORTH ATLANTIC. Lat. 22° 30′. Long. —72° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	8	13	5	1	0	1	1	0
Feb.	1	5	10	5	2	1	1	1	2
March	4	5	11	5	2	1	0	2	1
April	2	5	7	7	3	2	2	1	1
May	2	4	8	10	3	1	1	1	1
June	1	1	8	15	2	1	0	1	1
July	0	1	11	13	4	1	0	0	1
Aug.	1	3	10	12	4	1	0	0	0
Sept.	1	5	10	9	2	1	1	1	0
Oct.	2	6	10	8	2	1	0	1	1
Nov.	3	8	11	4	1	2	0	1	0
Dec.	4	8	12	5	1	0	0	1	0
Year	23	59	121	98	27	12	6	11	8

NORTH ATLANTIC. Lat. 22° 30′. Long. —77° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	7	2	2	2	5	4	4	0
Feb.	5	6	2	1	4	3	4	3	0
March	7	4	1	2	4	6	2	5	0
April	5	6	4	2	2	5	2	4	0
May	5	4	1	2	5	8	4	2	0
June	2	5	2	4	4	8	2	2	1
July	3	2	2	2	3	12	5	2	0
Aug.	5	6	2	2	3	7	4	1	1
Sept.	5	8	5	2	1	4	2	2	1
Oct.	8	9	2	3	2	2	2	3	0
Nov.	9	6	3	2	2	2	1	5	0
Dec.	8	5	2	2	3	4	1	5	1
Year	67	68	28	26	35	66	33	38	4

NORTH ATLANTIC. Lat. 32° 30′. Long. —12° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*

MONTH.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	8	5	6	2	2	2	2	0
Feb.	2	6	5	3	2	4	3	2	0
March	9	8	3	1	2	2	3	2	1
April	8	8	1	0	1	4	4	4	0
May	8	9	2	1	2	4	4	1	0
June	11	14	1	0	1	1	1	1	0
July	14	11	0	0	0	1	2	3	0
Aug.	10	12	1	0	1	3	2	1	1
Sept.	9	8	2	2	2	4	2	1	0
Oct.	5	12	5	2	1	4	1	1	0
Nov.	4	8	4	4	4	4	1	1	0
Dec.	5	9	6	3	2	2	1	3	0
Year	90	113	35	22	20	35	26	22	2

* About 1 P.M. Greenwich Mean Time.

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —22° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	7	4	6	4	2	3	3	0
Feb.	3	3	3	3	4	5	5	2	0
March	5	10	1	3	2	4	2	4	0
April	6	8	4	1	1	3	3	4	0
May	8	7	4	1	2	4	2	3	0
June	5	14	2	3	2	1	1	2	0
July	5	18	4	1	0	0	1	2	0
Aug.	5	15	3	1	1	2	1	2	1
Sept.	5	13	2	2	2	4	1	1	0
Oct.	2	11	7	4	1	3	1	1	1
Nov.	2	9	5	2	2	4	3	3	0
Dec.	6	6	6	5	2	3	0	3	0
Year	54	121	45	32	23	35	23	30	2

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —32° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	3	4	7	4	3	2	5	1
Feb.	3	3	2	3	3	6	4	4	0
March	4	6	4	4	2	6	2	3	0
April	4	3	5	4	3	6	3	2	0
May	6	6	3	2	2	5	2	5	0
June	3	7	5	5	4	3	1	2	0
July	4	6	10	4	2	1	2	2	0
Aug.	3	9	8	2	3	1	2	2	1
Sept.	3	7	6	5	3	3	1	2	0
Oct.	2	6	6	6	6	2	1	2	0
Nov.	3	6	5	5	4	2	1	4	0
Dec.	5	7	5	5	3	3	1	2	0
Year	42	69	63	52	39	41	22	35	2

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —42° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	6	5	3	3	5	0
Feb.	3	3	2	3	2	5	4	6	0
March	2	3	3	5	5	6	3	4	0
April	2	1	3	4	6	7	3	3	1
May	4	4	3	5	3	5	4	2	1
June	2	3	4	8	6	2	2	3	0
July	2	3	3	6	6	6	3	1	1
Aug.	2	4	8	7	6	2	1	1	0
Sept.	3	4	6	5	5	3	1	3	0
Oct.	3	6	5	5	6	3	1	2	0
Nov.	3	5	5	4	5	2	3	3	0
Dec.	3	5	4	4	6	5	1	3	0
Year	33	44	48	62	61	49	29	36	3

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —52° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	3	3	4	4	4	6	0
Feb.	3	2	3	2	3	5	4	5	1
March	2	2	1	2	5	10	4	5	0
April	3	3	1	4	7	6	4	2	0
May	2	1	2	7	7	6	3	2	1
June	2	1	3	3	10	6	2	3	0
July	1	1	1	7	9	6	4	1	1
Aug.	2	1	3	7	11	5	1	1	0
Sept.	3	3	4	5	7	3	3	2	0
Oct.	2	6	4	5	7	4	1	2	0
Nov.	3	5	4	4	5	4	2	3	0
Dec.	3	4	2	4	5	5	3	5	0
Year	29	33	31	53	80	64	35	37	3

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —62° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	3	2	2	4	6	5	4	1
Feb.	3	2	1	3	3	6	4	5	1
March	3	2	1	2	5	5	5	8	0
April	3	3	2	2	4	5	4	6	1
May	2	2	1	4	9	7	3	3	0
June	3	1	1	3	10	7	2	2	1
July	1	0	1	3	11	9	5	1	0
Aug.	1	1	3	6	11	6	1	2	0
Sept.	4	4	4	5	5	3	3	2	0
Oct.	4	6	4	6	3	4	2	2	0
Nov.	5	4	5	2	4	4	2	4	0
Dec.	4	5	2	2	5	4	3	5	1
Year	37	33	27	40	74	66	39	44	5

Month.	NORTH ATLANTIC. Lat. 32° 30′. Long. —72° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	4	2	2	5	5	2	6	0
Feb.	4	4	2	2	5	4	3	4	0
March	8	2	1	2	3	6	3	6	0
April	6	4	3	1	3	5	3	4	1
May	4	4	1	3	6	8	2	2	1
June	2	2	1	5	8	8	2	1	1
July	2	1	1	2	9	11	3	2	0
Aug.	2	4	2	2	10	6	2	2	1
Sept.	5	4	5	5	4	3	1	2	1
Oct.	6	10	5	3	2	1	1	3	0
Nov.	7	6	2	3	2	2	1	6	1
Dec.	6	4	1	3	3	5	1	7	1
Year	57	49	26	33	60	64	24	45	7

Month.	NORTH ATLANTIC. Lat. 42° 30′. Long. —12° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	3	1	2	5	7	4	6	0
Feb.	2	3	2	2	3	9	5	2	0
March	3	9	1	1	2	7	4	3	1
April	4	6	1	1	1	4	5	8	0
May	6	4	1	1	1	6	6	5	1
June	7	7	0	0	1	2	3	8	2
July	6	9	0	1	0	4	5	6	0
Aug.	7	8	0	1	1	3	4	7	0
Sept.	4	5	1	1	3	5	5	6	0
Oct.	5	7	2	1	3	3	3	7	0
Nov.	3	2	3	3	4	7	4	4	0
Dec.	5	6	1	2	3	7	4	3	0
Year	55	69	13	16	27	64	52	65	4

Month.	NORTH ATLANTIC. Lat. 42° 30′. Long. —22° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	1	5	8	6	7	0
Feb.	2	1	1	3	3	7	6	5	0
March	4	6	1	1	3	6	5	5	0
April	2	3	2	2	1	4	5	11	0
May	4	3	2	1	2	6	5	8	0
June	4	3	1	3	4	3	4	8	0
July	3	3	1	1	2	3	5	12	1
Aug.	4	4	1	1	2	6	6	7	0
Sept.	4	8	5	5	3	1	1	2	1
Oct.	3	7	5	5	4	2	2	3	0
Nov.	2	3	2	1	4	7	6	5	0
Dec.	2	4	2	2	3	7	7	4	0
Year	36	46	24	26	36	60	58	77	2

Month.	NORTH ATLANTIC. Lat 42° 30′. Long. —32° 30′. Height 0 ft. 5½ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	1	4	9	7	7	0
Feb.	3	0	1	1	4	8	4	7	0
March	3	1	1	2	4	10	6	4	0
April	2	2	2	2	3	9	4	6	0
May	2	5	2	1	2	8	4	7	0
June	2	2	2	4	2	10	4	4	0
July	2	1	0	2	5	8	6	7	0
Aug.	2	2	1	1	4	8	6	6	1
Sept.	3	2	1	2	4	6	7	5	0
Oct.	1	2	1	3	5	7	3	9	0
Nov.	2	2	1	2	4	8	4	7	0
Dec.	2	3	2	2	3	9	5	5	0
Year	25	23	15	23	44	100	60	74	1

* About 1 P.M. Greenwich Mean Time.

Month.	NORTH ATLANTIC. Lat. 42° 30′. Long. —42° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 42° 30′. Long. —52° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 42° 30′. Long. —62° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	1	1	4	6	5	9	0	3	2	1	2	5	6	4	7	1	5	3	1	2	3	4	6	7	0
Feb.	4	1	1	0	3	7	4	8	0	4	1	1	2	4	4	4	8	0	4	3	1	2	3	3	4	8	0
March	4	1	1	2	8	5	4	6	0	3	2	2	3	6	5	4	6	0	6	2	2	2	3	3	3	10	0
April	3	2	2	1	4	8	4	6	0	5	1	1	4	6	3	3	7	0	6	3	2	4	3	2	2	7	1
May	3	2	2	1	4	8	3	7	1	4	2	1	2	8	6	3	5	0	4	3	2	4	5	6	3	4	0
June	2	2	2	2	4	10	4	3	1	3	1	2	2	5	11	4	2	0	3	3	1	3	4	7	5	3	1
July	2	2	1	1	4	9	7	4	1	2	1	2	2	4	13	3	4	0	2	2	1	2	7	8	5	4	0
Aug.	2	0	1	1	5	10	5	6	1	2	1	1	2	7	9	5	3	1	4	2	2	1	6	7	4	5	0
Sept.	5	1	2	2	5	6	4	5	0	5	2	2	4	5	4	3	4	1	4	4	2	3	3	5	4	4	1
Oct.	4	1	1	2	5	7	4	7	0	4	2	2	4	4	6	2	7	0	5	5	1	3	3	5	2	7	0
Nov.	2	1	1	2	4	7	6	7	0	3	2	1	3	4	5	6	6	0	3	4	1	2	4	4	5	7	0
Dec.	3	2	0	2	4	10	4	6	0	4	2	2	3	4	6	3	7	0	5	8	5	4	3	2	1	3	0
Year	38	16	15	17	54	93	54	74	4	42	19	18	33	62	78	44	66	3	51	42	21	32	47	56	44	69	3

Month.	NORTH ATLANTIC. Lat. 42° 30′. Long. —67° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 52° 30′. Long. —12° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 52° 30′. Long. —22° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	6	2	2	3	2	3	4	8	1	1	2	2	4	6	5	8	3	...	1	1	1	3	5	7	7	6	...
Feb.	6	1	2	3	2	4	2	8	0	1	1	1	2	5	8	7	3	...	1	2	1	2	6	8	2	6	...
March	6	2	2	2	3	2	4	9	1	4	3	1	3	5	6	4	5	...	3	2	1	3	5	5	5	7	...
April	7	3	3	2	2	3	3	6	1	3	3	4	4	5	4	4	3	...	2	4	1	4	5	4	4	6	...
May	3	3	4	4	3	5	2	6	1	4	5	1	2	4	6	4	5	...	7	4	2	3	3	5	2	5	...
June	3	2	2	2	5	6	5	4	1	4	1	1	2	3	5	7	7	...	2	1	1	1	4	7	7	7	...
July	3	2	1	2	6	9	3	4	1	2	1	0	1	5	8	7	7	...	4	1	0	1	3	6	8	8	...
Aug.	5	3	1	2	6	6	4	3	1	2	1	1	1	5	8	8	5	...	1	1	2	3	4	8	5	7	...
Sept.	5	4	2	2	4	4	3	4	2	2	1	2	4	3	7	6	5	...	4	1	1	3	2	6	7	6	...
Oct.	8	3	3	3	2	5	2	5	0	3	3	2	3	3	5	6	6	...	2	1	1	2	4	7	7	7	...
Nov.	4	2	2	1	4	3	4	9	1	2	0	1	3	6	5	7	6	...	2	1	1	3	4	6	7	6	...
Dec.	5	4	2	2	3	5	3	7	0	3	2	2	1	5	6	7	5	...	3	2	1	1	3	7	9	5	...
Year	61	31	26	28	42	55	39	73	10	31	23	18	30	55	73	75	60	...	32	21	13	29	48	76	70	76	...

Month.	NORTH ATLANTIC. Lat. 52° 30′. Long. —32° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 52° 30′. Long. —42° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*									NORTH ATLANTIC. Lat. 52° 30′. Long. —47° 30′. Height 0 ft. $5\frac{1}{2}$ Years, 1881–86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	0	3	3	6	8	7	1	2	2	0	1	2	7	6	11	0	4	1	1	1	2	4	6	12	0
Feb.	3	1	2	2	4	5	5	6	0	1	1	1	2	2	5	4	12	0	2	2	1	1	2	5	4	11	0
March	3	2	1	3	3	8	5	6	0	2	2	0	4	2	8	4	9	0	3	2	1	4	2	7	3	9	0
April	2	2	0	4	6	4	5	7	0	2	2	2	6	3	4	3	8	0	5	3	4	3	1	4	3	7	0
May	4	3	2	3	5	7	2	5	0	4	2	2	4	4	8	3	4	0	3	4	1	5	4	5	2	7	0
June	2	1	1	2	3	11	6	4	0	1	1	0	2	5	11	5	5	0	1	1	1	4	4	9	6	4	0
July	3	2	0	2	3	7	6	8	0	2	1	1	3	8	7	3	6	0	1	2	1	3	6	8	4	6	0
Aug.	2	2	1	1	3	8	6	8	0	3	2	1	2	5	8	4	6	0	4	2	1	2	5	6	4	6	1
Sept.	3	1	1	1	3	7	5	9	0	3	1	0	1	4	7	5	8	1	3	1	0	1	5	6	5	9	0
Oct.	2	1	1	1	4	6	6	10	0	3	1	0	2	4	5	5	11	0	2	1	1	1	3	6	6	11	0
Nov.	3	2	0	2	5	5	6	7	0	3	1	1	1	3	5	6	10	0	4	1	0	3	3	5	4	10	0
Dec.	2	2	0	2	2	9	6	8	0	2	1	0	2	3	8	6	9	0	2	1	2	1	4	5	6	10	0
Year	30	21	9	26	44	83	66	85	1	28	17	8	30	45	83	54	99	1	34	21	14	29	41	70	53	102	1

* About 1 P.M. Greenwich Mean Time.

Month.	NORTH ATLANTIC. Lat. 57° 30′. Long. —12° 30′. Height 0 ft. 5½ Years, 1881-86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	1	6	2	7	6	6	...
Feb.	2	3	1	2	5	10	3	2	...
March	3	4	1	2	5	8	3	5	...
April	2	5	4	5	5	5	3	1	...
May	6	6	3	3	3	5	2	3	...
June	4	3	1	2	3	7	5	5	...
July	4	3	2	4	5	6	3	4	...
Aug.	5	2	1	2	4	10	3	4	...
Sept.	3	2	2	3	5	8	5	2	...
Oct.	2	2	3	4	4	6	4	5	...
Nov.	3	1	1	3	4	9	5	5	...
Dec.	2	3	1	2	2	9	7	5	...
Year	37	36	21	38	47	90	49	47	...

Month.	NORTH ATLANTIC. Lat. 57° 30′. Long. —22° 30′. Height 0 ft. 5½ Years, 1881-86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	2	4	3	6	6	7	0
Feb.	3	4	2	3	3	8	3	2	0
March	2	3	2	5	2	6	4	7	0
April	2	7	2	6	3	4	3	3	0
May	4	6	2	3	1	5	3	3	4
June	3	3	1	2	3	7	6	4	1
July	4	4	2	2	4	4	6	5	0
Aug.	4	2	2	4	3	6	5	5	0
Sept.	3	1	2	2	5	6	6	4	1
Oct.	2	3	1	3	4	7	5	6	0
Nov.	2	2	2	4	3	6	5	6	0
Dec.	1	2	1	3	3	8	6	7	0
Year	31	39	21	41	37	73	58	59	6

Month.	NORTH ATLANTIC. Lat. 57° 30′. Long. —32° 30′. Height 0 ft. 5½ Years, 1881-86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	N.W	W.	CA.
Jan.	1	2	2	4	2	4	6	10	0
Feb.	3	2	2	4	2	4	3	8	0
March	2	3	1	6	3	4	3	9	0
April	4	4	2	6	2	4	3	5	0
May	3	6	3	5	3	3	2	6	0
June	2	1	1	1	4	10	6	5	0
July	5	3	1	3	2	6	5	6	0
Aug.	4	3	2	3	2	5	3	8	1
Sept.	3	2	2	1	5	7	3	6	1
Oct.	3	1	1	3	4	6	4	9	0
Nov.	5	2	1	3	4	3	5	7	0
Dec.	1	2	1	3	3	8	5	8	0
Year	36	31	19	42	36	64	48	87	2

Month.	NORTH ATLANTIC. Lat. 57° 30′. Long. —42° 30′. Height 0 ft. 5½ Years, 1881-86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	1	1	2	6	4	10	0
Feb.	4	3	1	2	1	2	3	12	0
March	4	3	2	3	3	6	2	8	0
April	6	3	2	4	3	2	2	7	1
May	5	6	3	3	4	3	3	4	0
June	2	2	1	2	6	9	4	3	1
July	4	3	3	2	6	5	3	5	0
Aug.	4	3	1	4	5	4	4	5	1
Sept.	4	3	1	2	5	5	3	7	0
Oct.	3	2	1	3	4	5	4	9	0
Nov.	5	3	1	4	1	3	4	9	0
Dec.	4	2	1	2	3	6	4	9	0
Year	48	37	18	32	43	56	40	88	3

Month.	NORTH ATLANTIC. Lat. 57° 30′. Long. —47° 30′. Height 0 ft. 5½ Years, 1881-86. Hour.*								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	7	3	1	0	1	3	2	14	0
Feb.	5	4	1	0	1	3	2	12	0
March	5	3	2	2	3	4	2	9	1
April	9	3	2	2	1	1	3	7	2
May	6	5	3	3	3	4	1	5	1
June	2	2	1	2	6	7	6	4	0
July	5	3	3	4	5	3	4	4	0
Aug.	5	3	2	3	5	3	3	6	1
Sept.	3	4	1	3	4	3	3	8	1
Oct.	5	1	1	2	3	5	3	11	0
Nov.	6	3	1	3	1	3	3	10	0
Dec.	3	3	1	1	4	4	4	11	0
Year	61	37	19	25	37	43	36	101	6

* About 1 P.M. Greenwich Mean Time.

ADDENDA TO TABLE VII.

Month.	ST. MARTIN-DE-HINX. Lat. 43° 35′. Long. —1° 16′. Height 131 ft. Hours 6, 9, N. : 3, 6, 9. 20 Years, 1867–86.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	5	7	3	2	4	4	2	1
Feb.	2	3	6	3	2	3	5	3	1
March	4	3	4	2	2	3	6	5	2
April	2	2	4	2	2	3	7	6	2
May	3	3	4	2	1	3	7	6	2
June	3	2	3	1	1	3	8	7	2
July	3	2	3	2	1	2	8	7	3
Aug.	3	2	4	2	1	2	7	6	4
Sept.	3	2	5	2	2	3	5	5	3
Oct.	3	3	5	3	2	4	5	4	2
Nov.	3	4	6	3	2	4	4	3	1
Dec.	3	4	7	3	2	4	4	2	2
Year	35	35	58	28	20	38	70	56	25

Month.	PAPHO. Lat. 34° 46′. Long. 32° 25′. Height 230 ft. 7 Years, 1881–87. Hours 9 : 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	8	2	2	2	4	3	2
Feb.	4	2	9	1	1	2	5	3	1
March	3	2	9	1	1	2	8	4	1
April	5	1	9	1	1	1	8	3	1
May	4	1	9	1	2	1	10	2	1
June	4	1	6	1	2	1	9	4	2
July	7	0	6	1	3	2	9	3	0
Aug.	4	1	8	1	2	1	7	3	4
Sept.	7	1	7	1	2	1	7	3	1
Oct.	4	2	9	0	1	1	6	3	5
Nov.	4	2	8	2	3	1	5	2	3
Dec.	4	2	11	2	2	1	5	3	1
Year	55	18	99	14	22	16	83	36	22

Month.	LIMASSOL. Lat. 34° 40′. Long. 33° 1′. Height 26 ft. 6 Years, 1882–87. Hours 9 : 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	8	5	4	4	2	1	...
Feb.	2	3	6	6	5	3	2	1	...
March	2	3	5	4	5	6	4	2	...
April	1	2	4	4	4	8	6	1	...
May	2	2	2	5	6	6	7	1	...
June	1	1	3	4	5	6	8	2	...
July	1	2	2	4	6	7	8	1	...
Aug.	1	2	4	4	5	4	8	3	...
Sept.	1	1	3	4	5	3	10	3	...
Oct.	1	2	6	7	3	4	7	1	...
Nov.	1	3	8	9	3	3	2	1	...
Dec.	2	4	9	4	4	5	2	1	...
Year	18	29	60	60	55	59	66	18	...

Month.	LARNACA. Lat. 34° 55′. Long. 33° 37′. Height 350 ft. 7 Years, 1881–87. Hours 9 : 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	8	5	1	2	5	3	2	5	...
Feb.	6	3	1	2	4	4	4	4	...
March	6	4	1	4	5	5	3	3	...
April	5	4	2	3	7	4	3	2	...
May	3	2	2	6	8	4	4	2	...
June	3	2	1	4	9	4	5	2	...
July	3	1	1	6	9	4	5	2	...
Aug.	4	2	2	4	10	3	4	2	..
Sept.	2	2	2	4	8	4	5	3	...
Oct.	6	4	1	4	6	3	3	4	...
Nov.	6	5	1	2	2	4	5	5	...
Dec.	7	7	0	3	4	4	3	3	...
Year	59	41	15	44	77	46	46	37	...

Month.	FAMAGUSTA. Lat. 35° 7′. Long. 33° 57′. Height 75 ft. 6 Years, 1882-87. Hours 9 : 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	5	3	2	2	7	5	2	0
Feb.	4	5	1	1	2	5	6	2	2
March	3	5	2	1	3	8	5	2	2
April	3	5	3	1	3	6	6	3	0
May	2	4	4	2	8	6	3	2	0
June	1	3	6	2	6	6	4	1	1
July	1	5	6	2	5	7	3	1	1
Aug.	2	3	5	2	4	8	4	1	2
Sept.	2	2	2	1	3	10	5	2	3
Oct.	3	2	1	1	1	8	9	3	3
Nov.	3	3	2	1	2	10	7	2	0
Dec.	2	6	3	2	3	7	4	1	3
Year	31	48	38	18	42	88	61	22	17

Month.	KYRENIA. Lat. 35° 21′. Long. 33° 19′. Height 60 ft. 7 Years, 1881–87. Hours 9 : 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	3	8	2	2	1	4	1	5
Feb.	4	3	7	1	3	1	3	1	5
March	3	2	8	1	4	1	5	2	5
April	2	2	6	1	1	1	7	2	8
May	3	1	7	1	2	1	5	3	8
June	3	1	6	0	2	1	5	4	8
July	3	1	5	0	2	1	5	4	10
Aug.	2	2	4	1	1	0	5	3	13
Sept.	3	2	4	0	2	1	6	3	9
Oct.	2	2	5	1	2	1	4	3	11
Nov.	3	2	6	1	4	1	5	2	6
Dec.	3	2	7	2	3	1	6	2	5
Year	36	23	73	11	28	11	60	30	93

NICOSIA. Lat. 35° 11′. Long. 33° 22′. Height 509 ft. 7 Years, 1881–87. Hours 9 : 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	1	6	1	4	2	4	1	8
Feb.	5	1	3	1	3	2	4	3	6
March	4	1	5	2	3	1	6	4	5
April	3	1	5	2	3	1	5	5	5
May	3	2	3	1	2	2	7	6	5
June	3	1	4	1	2	1	7	6	5
July	3	2	5	1	1	1	8	7	3
Aug.	4	1	4	1	1	1	7	6	6
Sept.	3	2	3	1	2	1	6	6	6
Oct.	4	1	4	0	2	2	5	4	9
Nov.	4	1	4	1	2	2	5	2	9
Dec.	4	1	5	1	2	2	3	2	11
Year	44	15	51	13	27	18	67	52	78

KRASSNOWODSK. Lat. 40° 0′. Long. 52° 59′. Height —70 ft. 5 Years, 1883–87. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	2	8	4	1	0	0	2	9
Feb.	4	2	5	2	1	0	1	3	10
March	6	1	3	3	1	1	1	4	11
April	8	1	2	2	1	1	2	5	8
May	7	1	2	2	2	2	2	4	9
June	8	1	2	1	2	3	3	6	5
July	11	2	2	2	1	2	3	5	3
Aug.	10	2	4	2	1	2	2	5	3
Sept.	7	3	3	1	1	2	2	4	7
Oct.	4	1	4	3	1	1	2	5	9
Nov.	4	2	7	4	0	0	1	3	9
Dec.	3	2	7	7	1	0	1	3	7
Year	77	20	49	33	13	14	20	49	90

GURJEW. Lat. 47° 7′. Long. 51° 55′. Height —58 ft. Hours 7 : 1, 9. 4 Years, 1880–81, 83–84.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	8	6	1	2	6	2	3
Feb.	2	4	6	2	1	2	5	3	3
March	2	3	9	4	1	3	4	2	3
April	3	4	8	4	1	1	3	2	4
May	3	3	6	3	1	4	4	3	4
June	3	2	2	3	2	5	5	3	5
July	2	1	2	4	2	5	7	3	5
Aug.	3	1	2	4	2	4	5	3	7
Sept.	4	4	3	3	1	3	4	3	5
Oct.	3	3	3	5	2	3	4	3	5
Nov.	3	3	4	5	1	2	4	4	4
Dec.	2	2	6	5	1	3	5	3	4
Year	31	32	59	48	16	37	56	34	52

URALSK. Lat. 51° 43′. Long. 55° 55′. Height 358 ft. 4 Years, 1883–87. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	2	4	6	5	2	2	8
Feb.	2	2	3	2	3	4	3	2	7
March	2	4	4	4	4	4	3	1	5
April	3	4	3	5	4	3	2	2	4
May	2	2	3	5	5	4	3	3	4
June	3	3	4	4	3	3	4	4	2
July	4	3	4	3	2	3	4	5	3
Aug.	2	1	3	4	4	5	4	4	4
Sept.	2	2	1	4	5	4	4	4	4
Oct.	2	2	3	5	5	4	3	3	4
Nov.	1	2	2	6	5	4	3	3	4
Dec.	1	1	3	6	8	5	3	1	3
Year	25	27	35	52	54	48	38	34	52

KISYL-ARWAT. Lat. 39° 17′. Long. 56° 10′. Height 317 ft. 1 Year, 1886. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	5	13	0	1	1	2	3	5
Feb.	1	2	17	0	0	2	3	0	3
March	3	6	7	0	1	0	4	3	7
April	1	1	8	0	3	4	3	1	9
May	1	0	11	1	0	4	4	1	9
June	2	0	6	1	3	4	4	1	9
July	1	0	5	0	5	4	6	1	9
Aug.	1	1	11	0	2	2	3	0	11
Sept.	1	1	11	0	1	0	4	0	12
Oct.	3	2	11	0	0	0	2	1	12
Nov.	1	0	18	0	0	0	1	1	9
Dec.	1	0	15	0	1	0	2	0	12
Year	17	18	133	2	17	21	38	12	107

STARO-SSIDOROWA. Lat. 55° 26′. Long. 65° 10′. Height 322 ft. 5½ Years, 1882–87. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	1	1	0	10	4	5	2	6
Feb.	4	1	2	1	4	3	5	2	6
March	2	1	2	1	7	4	5	2	7
April	3	2	3	1	5	3	4	3	6
May	5	2	2	1	5	3	5	3	5
June	5	2	4	1	4	2	3	3	6
July	8	5	4	0	2	1	3	2	6
Aug.	6	2	3	1	3	2	4	4	6
Sept.	4	1	2	1	4	3	6	4	5
Oct.	4	1	1	1	5	4	6	3	6
Nov.	2	1	2	1	6	5	6	2	5
Dec.	2	1	1	1	7	6	6	2	5
Year	47	20	27	10	62	40	58	32	69

OSCH. Lat. 40° 33′. Long. 72° 47′. Height 3940 ft. 3 Years, 1884–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	2	1	1	3	1	0	0	22
Feb.	1	1	2	1	2	1	2	0	18
March	1	2	1	1	2	2	1	1	20
April	2	1	1	3	3	1	1	2	16
May	3	2	2	2	1	1	2	2	16
June	2	1	2	2	1	1	1	4	16
July	1	1	1	1	1	1	1	2	22
Aug.	1	2	1	2	1	1	1	2	20
Sept.	2	2	2	3	2	0	1	3	15
Oct.	2	1	2	3	2	1	0	4	16
Nov.	1	2	3	2	1	1	1	3	16
Dec.	2	5	2	2	1	1	1	2	15
Year	19	22	20	23	20	12	12	25	212

AULIE-ATA. Lat. 42° 53′. Long. 71° 23′. Height 2067 ft. 3 Years, 1884–86. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	3	4	1	1	5	3	1	1	12
Feb.	2	2	2	2	4	2	1	1	12
March	4	6	2	2	3	1	1	3	9
April	3	4	3	1	3	1	1	2	12
May	2	4	1	2	3	2	2	1	14
June	2	3	1	2	2	1	1	1	17
July	3	2	1	3	4	1	1	2	14
Aug.	4	3	1	2	4	2	1	2	12
Sept.	3	2	1	2	5	2	2	2	11
Oct.	3	2	1	3	7	2	1	2	10
Nov.	2	1	1	4	6	3	1	1	11
Dec.	1	2	1	4	7	2	1	1	12
Year	32	35	16	28	53	22	14	19	146

KOPAL. Lat. 45° 8′. Long. 79° 3′. Height (?) ft. 2½ Years, 1885–87. Hours 7 : 1, 9.

Month.	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	2	9	6	7	1	1	1	1	3
Feb.	2	6	7	6	1	2	1	1	2
March	3	6	7	5	2	1	2	3	2
April	2	7	5	4	2	3	2	3	2
May	3	7	3	4	3	2	2	3	4
June	2	8	3	4	3	3	2	3	2
July	2	6	5	3	2	3	2	4	4
Aug.	3	4	4	2	2	3	3	4	6
Sept.	2	4	4	4	2	4	1	3	6
Oct.	1	3	4	5	1	3	1	4	9
Nov.	1	3	4	4	6	4	1	2	5
Dec.	1	6	5	7	1	2	1	1	7
Year	24	69	57	55	26	31	19	32	52

Month.	BLAGOWESCHTSCHENSKIJ-PRIISK. Lat. 58° 0′. Long. 114° 9′. Height 168 ft. 4½ Years, 1883–87. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	10	9	2	1	1	2	1	0
Feb.	4	9	9	2	1	1	1	1	0
March	5	9	7	2	1	1	3	3	0
April	5	6	6	3	3	1	3	3	0
May	5	5	6	3	3	2	4	3	0
June	5	5	4	3	3	1	3	5	1
July	6	6	6	3	4	1	2	2	1
Aug.	7	6	5	2	4	1	3	2	1
Sept.	5	6	5	3	4	2	3	2	0
Oct.	7	5	5	3	3	2	4	2	0
Nov.	6	7	7	2	2	1	3	2	0
Dec.	6	8	9	2	1	1	2	2	0
Year	66	82	78	30	30	15	33	28	3

Month.	RYKOWSKOE. Lat. 50° 47′. Long. 142° 55′. Height 450 ft. 2 Years, 1886–87. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	5	1	0	0	1	0	0	11	13
Feb.	4	1	0	2	1	0	1	8	11
March	4	1	0	4	2	0	1	10	9
April	3	0	1	8	4	1	2	6	5
May	3	1	1	11	4	2	2	4	3
June	2	1	2	13	4	0	1	4	3
July	2	1	2	12	3	1	1	5	4
Aug.	1	0	1	11	2	1	3	5	7
Sept.	1	0	2	7	3	0	1	7	9
Oct.	1	0	1	5	2	1	3	7	11
Nov.	1	1	0	5	2	1	1	6	13
Dec.	2	0	1	2	0	0	1	10	15
Year	29	7	11	80	28	7	17	83	103

Month.	WÖNSAN. Lat. 39° 10′. Long. 127° 25′. Height (?) ft. 1 Year, 1887. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	1	1	1	3	3	11	2	8
Feb.	0	1	2	1	1	4	11	2	6
March	1	1	2	4	3	6	8	4	2
April	2	4	4	2	0	2	7	5	4
May	2	6	5	2	1	2	4	3	6
June	2	9	8	6	0	0	1	2	2
July	1	6	8	4	0	1	3	3	5
Aug.	2	3	4	2	1	3	1	3	12
Sept.	1	2	4	5	1	3	6	3	5
Oct.	0	1	4	5	1	3	4	4	9
Nov.	0	1	1	2	1	5	6	10	4
Dec.	1	1	0	2	1	2	5	14	5
Year	13	36	43	36	13	34	67	55	68

Month.	SÖUL. Lat. 37° 35′. Long. 127° 7′. Height 656 ft. 9 Months, 1887. Hours 7: 1, 9.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...
April	0	3	2	1	1	8	5	2	8
May	1	1	3	1	0	6	7	3	9
June	1	1	4	0	1	5	7	2	9
July	0	2	3	1	0	6	3	2	14
Aug.	1	2	4	0	1	4	3	2	14
Sept.	1	2	2	1	0	2	5	5	12
Oct.	1	3	6	0	1	2	2	3	13
Nov.	1	1	5	1	0	1	5	5	11
Dec.	1	4	2	0	0	2	2	8	12
Year	...	...	...	...	...	...	...	...	...

Month.	LICK OBSERVATORY, CAL. Lat 37° 20′. Long. —121° 39′. Height 4301 ft. 5 Years, 1881–85. Hours (?)								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	4	0	0	6	5	0	0	14	2
Feb.	5	1	0	5	6	0	0	11	0
March	4	0	0	8	4	2	0	12	1
April	5	2	0	3	4	4	0	11	1
May	4	0	0	4	2	4	0	17	0
June	4	0	0	1	2	1	0	19	3
July	2	1	0	1	0	2	2	17	6
Aug.	9	0	0	0	0	0	0	21	1
Sept.	3	0	0	2	1	0	0	19	5
Oct.	3	0	0	5	3	0	0	14	6
Nov.	3	1	0	4	2	0	0	19	1
Dec.	2	0	0	12	3	0	0	13	1
Year	48	5	0	51	32	13	2	187	27

Month.	POLARIS BAY. Lat. 81° 38′. Long. —61° 44′. Height 0 ft. 10 Months, 1871–72. Hourly.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	1	8	11	3	0	4	0	0	4
Feb.	1	10	10	1	1	2	0	1	2
March	0	11	6	4	0	2	1	1	6
April	0	3	8	5	0	2	1	2	9
May	0	8	1	4	1	10	1	1	5
June	1	6	1	2	3	7	2	2	6
July	3	6	2	3	2	9	2	1	3
Aug.	3	2	0	8	2	6	2	3	5
Sept.	...	...	...	...	...	...	...	...	...
Oct.	...	...	...	...	...	...	...	...	...
Nov.	0	15	8	1	0	4	0	0	2
Dec.	0	9	10	0	1	5	0	2	4
Year	...	...	...	...	...	...	...	...	...

Month.	FORT MACPHERSON. Lat. 68° 0′. Long. —135° 0′. Height 0 ft. 10 Months, 1863. Hours 3 times daily.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	...	...	...	...	...	...	...	...	...
Feb.	6	0	15	0	2	0	2	0	3
March	7	0	9	0	4	0	4	7	0
April	4	0	1	4	4	2	8	7	0
May	0	17	1	0	0	5	1	5	1
June	15	1	3	4	2	0	3	1	1
July	11	0	12	3	1	1	3	0	0
Aug.	6	2	12	8	0	0	3	0	0
Sept.	24	0	1	0	3	0	0	1	1
Oct.	18	3	1	4	3	0	1	1	0
Nov.	3	0	20	2	1	0	2	1	1
Dec.	...	...	...	...	...	...	...	...	...
Year	...	...	...	...	...	...	...	...	...

Month.	FORT ANDERSON. Lat. 68° 30′. Long. —127° 30′. Height (?) ft. Hours 3 times daily. 11 Months, 1863–64.								
	N.	N.E	E.	S.E.	S.	S.W	W.	N.W	CA.
Jan.	9	2	6	1	4	2	5	2	...
Feb.	8	2	3	1	4	3	4	3	...
March	12	1	4	2	5	1	5	1	...
April	12	3	4	1	4	1	4	1	...
May	8	2	5	2	6	1	5	2	...
June	11	2	4	1	6	1	4	1	...
July	12	2	2	2	5	2	5	1	...
Aug.	...	...	...	...	...	...	...	...	...
Sept.	10	2	3	2	4	1	5	3	...
Oct.	12	2	3	0	6	2	4	2	...
Nov.	9	2	2	1	6	3	5	2	...
Dec.	8	1	3	1	9	1	6	2	...
Year	...	...	...	...	...	...	...	...	...

TABLE VIII.

(SUPPLEMENTARY TO TABLE VII.)

SHOWING THE PREVAILING WINDS EACH MONTH OF THE YEAR IN DIFFERENT PARTS OF THE WORLD.

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Quetta, . .	Beloochistan	8	1878–85	10 : 4	30	11	67	3	5500
Lek, . . .	India	10	1875–84	4, 10 : 4, 10	34	10	77	42	11503
Peshawar, . .	do.	10	1876–85	10 : 4	34	2	71	37	1110
Dera Ismail Khan,	do.	15	1870–84	do.	32	0	71	5	573
Mooltan, . .	do.	15	do.	do.	30	10	71	33	420
Murree, . .	do.	10	1875–84	do.	33	54	73	27	6344
Lahore, . .	do.	15	1870–84	4, 10 : 4, 10	31	34	74	20	732
Simla, . . .	do.	6	1880–85	10 : 4	31	6	77	12	7012
Delhi, . . .	do.	10	1875–84	do.	28	40	77	16	718
Agra, . . .	do.	15	1870–84	do.	27	10	78	5	555
Gorakhpur, . .	do.	15	do.	do.	26	46	83	18	256
Jhansi, . .	do.	15	do.	do.	25	27	78	37	855
Allahabad, . .	do.	15	do.	4, 10 : 4, 10	25	26	81	52	307
Sibsagar, . .	do.	10	1875–84	10 : 4	26	59	94	40	333
Darjeeling, . .	do.	4	1882–85	do.	27	3	88	18	7421
Dhubri, . .	do.	4	do.	4, 10 : 4, 10	26	7	89	50	115
Silchar, . .	do.	15	1870–84	10 : 4	24	49	92	50	104
Gya, . . .	do.	15	do.	do.	24	42	85	2	375
Berhampore, .	do.	15	do.	do.	24	6	88	17	66
Dacca, . . .	do.	15	do.	do.	23	43	90	27	35
Chittagong, . .	do.	15	do.	4, 10 : 4, 10	22	21	91	50	87
Calcutta, . .	do.	15	do.	do.	22	32	88	20	21
Saugor Island, .	do.	15	do.	do.	21	39	88	5	25
False Point, . .	do.	15	do.	10 : 4	20	20	86	47	21
Sambulpur, . .	do.	15	do.	do.	21	31	84	1	463
Nagpur, . .	do.	15	do.	4, 10 : 4, 10	21	9	79	11	1025
Jubbalpore, . .	do.	15	do.	10 : 4	23	9	79	59	1341
Hoshangabad, .	do.	15	do.	do.	22	45	77	46	1020
Khandwa, . .	do.	15	do.	do.	21	49	76	23	1044
Bikaneer, . .	do.	6–8	1878–85	do.	27	59	73	14	744
Ajmere, . .	do.	15	1870–84	do.	26	28	74	37	1611
Pachpadra, . .	do.	6	1880–85	do.	25	55	72	18	380
Jacobabad, . .	do.	8	1878–85	do.	28	24	68	18	186
Hyderabad, . .	do.	8	do.	do.	25	25	68	27	134
Kurrachee, . .	do.	17	1867–84	do.	24	47	67	4	49
Rajkot, . .	do.	8	1878–85	do.	22	17	70	52	429
Deesa, . . .	do.	17	1868–84	4, 10 : 4, 10	24	16	72	14	466
Surat, . . .	do.	8	1878–85	10 : 4	21	13	72	46	36
Bombay, . .	do.	16	1869–84	4, 10 : 4, 10	18	54	72	49	37
Ratnagiri, . .	do.	8	1877–84	10 : 4	17	6	73	23	110
Karwar, . .	do.	8	1878–85	do.	14	50	74	15	44
Visagapatam, .	do.	15	1870–84	4, 10 : 4, 10	17	42	83	22	31
Masulipatam, .	do.	10	1875–84	10 : 4	16	9	81	12	10
Secunderabad, .	do.	10	do.	do.	17	27	78	33	1787
Bellary, . .	do.	10	do.	do.	15	9	76	57	1455
Madras, . .	do.	15	1870–84	do.	13	4	80	14	22
Coimbatore, . .	do.	10	1875–84	do.	11	0	77	0	1348
Negapatam, . .	do.	10	do.	do.	10	46	79	53	15
Cochin, . .	do.	10	do.	do.	9	58	76	17	11
Jaffna, . . .	do.	10	do.	$9\frac{1}{2} : 3\frac{1}{2}$	9	40	79	56	9

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
°	°	°	°	°	°	°	°	°	°	°	°
N 84 W	N 83 W	S 58 W	N 83 W	N 71 W	N 66 W	N 87 W	N 77 W	N 57 W	N 55 W	N 34 W	N 46 W
S 21 W	S 15 W	S 47 W	S 48 W	S 69 W	S 78 W	S 67 W	S 68 W	S 51 W	S 52 W	S 31 W	S 15 W
S 6 E	N 39 W	N 16 E	N 10 E	N 25 E	N 50 E	N 56 E	N 42 E	N 41 E	N 61 E	N 85 E	S 20 E
N 7 W	N 4 W	N 40 E	N 46 E	N 79 E	N 87 E	S 79 E	S 75 E	S 88 E	N 75 E	N 51 E	N 3 E
N 9 W	N 5 E	N 11 W	N 26 W	N 70 W	S 35 W	S 25 W	S 19 W	S 32 W	S 70 W	S 73 W	N 14 E
S 68 E	S 44 E	S 37 E	S 73 E	S 11 E	S 1 E	S 3 W	S 6 W	N 84 E	S 13 E	S 57 E	S 68 E
N 25 W	N 25 W	N 10 W	N 19 W	N 7 E	N 19 W	S 84 E	S 83 E	N 60 E	N 3 W	N 47 W	N 36 W
S 48 W	S 38 W	S 50 W	S 49 W	W	S 87 W	N 87 W	N 73 W	N 68 W	N 53 W	N 84 W	N 62 W
N 77 W	N 66 W	N 62 W	N 65 W	N 49 W	N 60 W	S 45 E	S 19 W	N 32 W	N 49 W	N 59 W	N 67 W
N 64 W	N 75 W	N 70 W	N 84 W	N 72 W	N 60 W	N 63 E	S 22 E	N 26 W	N 78 W	N 81 W	N 64 W
S 85 W	N 84 W	N 81 W	N 67 W	S 82 E	S 74 E	S 79 E	S 62 E	S 70 E	N 83 W	N 79 W	N 86 W
N 34 E	N	N 80 W	S 78 W	N 81 W	S 76 W	S 49 W	S 64 W	N 50 W	N 30 W	N 1 E	N 26 E
N 34 W	N 66 W	N 65 W	N 52 W	N 8 E	N 2 E	N 84 E	N 40 E	N 42 E	N 42 W	N 65 W	N 54 W
N 62 E	N 61 E	N 61 E	N 61 E	N 57 E	S 83 E	S 11 W	S 57 W	N 66 E	N 66 E	N 64 E	N 67 E
S 84 W	S 83 W	S 77 W	S 72 W	S 79 W	S 88 E	N 88 E	N 84 E	S 72 E	S 3 E	N 61 W	N 54 W
N 77 E	S 64 E	S 87 E	S 85 E	N 64 E	S 74 E	S 70 E	S 47 E	S 80 E	N 55 E	N 59 E	N 67 E
S 29 E	S 33 E	S 60 E	S 86 E	N 75 E	N 58 E	N 6 W	S 63 W	S 89 W	S 56 E	S 77 E	S 57 E
N 60 W	N 72 W	N 79 W	N 72 W	N 17 E	N 57 E	S 79 E	S 66 E	S 86 E	N 34 W	N 45 W	N 68 W
N 41 W	N 72 W	S 76 W	S 23 W	S 36 E	S 33 E	S 41 E	S 40 E	S 41 E	N 12 W	N 25 W	N 26 W
N 53 W	S 76 W	S 23 W	S 4 E	S 19 E	S 16 E	S 19 E	S 14 E	S 11 E	S 55 E	N 17 W	N 36 W
N 24 W	N 38 W	S 54 W	S 12 W	S	S 31 E	S 40 E	S 32 E	S 29 E	N 10 W	N 20 W	N 23 W
N 38 W	S 81 W	S 32 W	S 3 W	S 11 E	S 4 E	S 11 E	S 17 E	S 27 E	N 48 W	N 17 W	N 26 W
N 1 E	S 50 W	S 33 W	S 20 W	S 12 W	S 15 W	S 24 W	S 17 W	S 4 W	N 10 E	N 5 E	N 7 E
N 51 E	S 12 W	S 38 W	S 38 W	S 31 W	S 45 W	S 59 W	S 57 W	S 25 W	N 40 E	N 22 E	N 43 E
N 56 W	N 42 W	S 59 W	S 65 W	S 78 W	S 45 W	S 48 W	S 55 W	N 72 W	N 27 E	N 19 E	N 23 E
N 72 E	N 55 E	N 20 W	N 63 W	N 41 W	N 76 W	N 88 W	N 76 W	N 54 W	N 37 E	N 60 E	N 64 E
N 8 E	N 13 W	N 69 W	N 66 W	N 62 W	N 80 W	N 87 W	N 84 W	N 69 W	N 3 E	N 47 E	N 32 E
N 59 E	N 58 E	N 55 W	N 89 W	W	S 88 W	S 76 W	S 79 W	N 86 W	N 12 E	N 60 E	N 61 E
N 20 E	N 11 W	N 48 W	N 52 W	N 61 W	N 75 W	N 83 W	N 80 W	N 69 W	N 24 E	N 70 E	N 66 E
N 42 E	N 9 W	S 74 W	S 77 W	S 78 W	S 51 W	S 39 W	S 37 W	S 55 W	S 69 W	S 44 W	N 63 E
N 82 E	S 77 W	S 61 W	S 74 W	S 60 W	S 61 W	S 62 W	S 70 W	S 80 W	N 76 W	N 32 E	N 84 E
N 58 E	N 50 E	S 37 W	S 47 W	S 44 W	S 38 W	S 35 W	S 39 W	S 49 W	S 39 W	N 52 E	N 52 E
N 5 W	N 23 E	N 62 E	S 86 E	S 64 E	S 29 E	S 49 E	S 55 E	S 40 E	S 44 E	N 11 W	N 13 W
N 15 W	N 31 W	N 87 W	S 53 W	S 47 W	S 37 W	S 41 W	S 42 W	S 42 W	S 60 W	N 22 W	N 10 W
N 50 E	N 61 W	N 84 W	N 87 W	S 86 W	S 81 W	W	N 87 W	N 89 W	S 88 W	N 42 W	N 55 E
N 22 E	N 4 W	N 41 W	N 53 W	N 82 W	S 73 W	S 77 W	S 81 W	N 80 W	N 5 E	N 45 E	N 43 E
N 3 W	N 28 W	N 88 W	N 89 W	S 55 W	S 36 W	S 40 W	S 47 W	S 65 W	N 62 W	N 33 E	N 17 E
N 20 E	N 10 W	N 43 W	N 68 W	S 55 W	S 43 W	S 47 W	S 57 W	S 66 W	N 16 E	N 50 E	N 51 E
N 12 W	N 14 W	N 38 W	N 61 W	N 85 W	S 57 W	S 65 W	S 70 W	S 84 W	N 25 W	N 4 W	N 3 W
N 50 W	N 66 W	N 80 W	N 81 W	N 76 W	S 51 W	S 54 W	S 70 W	S 80 W	S 85 W	N 11 W	N 8 W
N 5 W	N 52 W	N 81 W	N 85 W	N 70 W	S 80 W	S 73 W	S 88 W	N 89 W	N 83 W	N 25 W	N 2 E
S 60 E	S 11 W	S 45 W	S 48 W	S 41 W	S 58 W	S 74 W	S 74 W	S 60 W	S 65 E	N 75 E	N 83 E
N 69 E	S 73 E	S 20 E	S 3 W	S 19 W	S 74 W	S 81 W	S 84 W	S 77 W	N 29 E	N 58 E	N 58 E
S 89 E	S 74 E	S 64 E	S 6 W	N 77 W	S 79 W	S 73 W	S 87 W	N 86 W	N 30 E	N 53 E	N 63 E
S 70 E	S 56 E	S 27 E	S 51 W	N 78 W	W	S 89 W	N 85 W	N 78 W	N 17 E	N 84 E	S 85 E
N 48 E	E	S 50 E	S 40 E	S 15 E	S 36 W	S 46 W	S 40 W	S 36 W	N 35 E	N 24 E	N 24 E
N 74 E	N 82 E	S 76 E	S 21 E	S 17 W	S 41 W	S 44 W	S 33 W	S 34 W	S 8 E	N 78 E	N 69 E
N 47 E	N 65 E	S 61 E	S 36 E	S 11 W	S 45 W	S 49 W	S 48 W	S 44 W	S 51 W	N 34 E	N 38 E
S 6 E	S 74 W	W	N 89 W	S 84 W	S 72 W	S 78 W	S 85 W	N 89 W	S 70 W	S 33 W	S 29 W
N 43 E	N 51 E	S 69 E	S 10 W	S 39 W	S 43 W	S 42 W	S 41 W	S 44 W	S 49 W	N 28 E	N 34 E

Places.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Colombo, . .	India	11	1874–84	$9\frac{1}{2}$: $3\frac{1}{2}$	6 56	79 52	40
Galle, . . .	do.	11	do.	do.	6 1	80 14	48
Hambantota, .	do.	11	do.	do.	6 7	81 7	40
Kandy, . .	do.	11	do.	do.	7 18	80 40	1696
Newera Eliya, .	do.	11	do.	do.	6 46	80 47	6240
Batticoloa, . .	do.	11	do.	do.	7 43	81 44	26
Trincomalee . .	do.	11	do.	do.	8 33	81 15	175
Akyab, . .	do.	15	1870–84	10 : 4	20 28	92 57	20
Thaymetyo, . .	do.	8	1878–85	do.	19 22	95 12	134
Toungoo. . .	do.	8	do.	do.	18 57	96 24	169
Bassein, . .	do.	8	do.	do.	16 47	94 50	35
Diamond Island, .	do.	8	do.	do.	15 52	94 19	41
Rangoon, . .	do.	10	1876–85	4, 10 : 4, 10	16 46	96 12	41
Moulmein, . .	do.	7	1879–85	10 : 4	16 29	97 40	94
Mergui, . .	do.	8	1878–85	do.	12 11	98 38	96
Port Blair, . .	do.	15	1870–84	do.	11 41	92 42	61
Nancowry, . .	do.	10	1876–85	do.	8 0	93 46	81
Raffles Lighthouse,	do.	2	1866–67	A.M.	1 9	103 44	101
Bushire, . .	Persia	10	1876–85	10: 4	28 59	50 49	25
Aden, . . .	Arabia	6	1880–85	do.	12 45	45 3	94
Port Moresby, .	New Guinea	$1\frac{2}{3}$	1875–76	9 :	−9 32	146 10	278
Goodie Island, .	Queensland	1	1880	9 : 3, 9	−10 33	142 10	300
Brisbane, . .	New South Wales	3	1859–61	do.	−27 28	153 6	130
Thergomindah, .	do.	$1\frac{1}{2}$	1874–75	9 :	−28 0	142 30	450
Bourke, . .	do.	4	1874–76, '85	do.	−30 3	145 58	456
Wentworth, . .	do.	6	do.	do.	−34 8	142 0	141
Eden, . .	do.	6	do.	do.	−37 0	149 59	107
Derby, . . .	West Australia	$1\frac{1}{2}$	1884–85	do.	−17 18	123 39	17
Cossack, . .	do.	5	1881–85	do.	−20 40	117 8	19
Geraldton, . .	do.	6	1880–85	do.	−28 47	114 26	10
Albany, . .	do.	6	do.	do.	−35 2	117 51	88
York, . . .	do.	6	do.	do.	−31 53	116 47	580
Rapa, . . .	Pacific Ocean	$1\frac{1}{2}$	1867–69	8 :	−27 36	−144 11	0
do., . . .	do.	$1\frac{1}{2}$	do.	: 4	−27 36	−144 11	0
South Cape, . .	China	1	1885	3, 6, 9, N. : 3, 6, 9, M.	21 55	120 51	121
Victoria Peak, .	do.	1	do.	7, 10 : 1, 4, 7, 10	22 0	114 10	1816
Hongkong, . .	do.	4	1884–87	hourly	22 18	114 10	110
Banjermassing, .	East India Is.	9	1850–59	9 : 3	−3 0	114 30	10
Bangoewangi, .	do.	8	1850–57	6, 9 : 3, 10	−8 17	114 27	26
Palembang, . .	do.	7	1850–56	9 : 3	−2 50	104 53	20
Kita, . . .	Africa	2	1882–83	6 : 2, 9	10 0	−13 0	1090
Christiansborg, .	do.	5	1829–34	6 :	5 24	−0 10	66
do., . .	do.	5	do.	: 4	do.	do.	60
Central Africa, .	do.	1	1861–62	?	1 37	32 20	?
Zanzibar, . .	do.	5	1880–84	10 : 4	−6 10	39 11	23
Nossi-Be, . .	Madagascar	1	1879–80	various	−13 43	48 20	80
Wolstenholm Sound,	Arctic Regions	1	1849–50	four hourly	76 34	−68 45	0
Port Foulke, .	do.	1	1860–61	two hourly	78 18	−73 0	0

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
°	°	°	°	°	°	°	°	°	°	°	°
N 3 W	N 39 W	N 85 W	S 67 W	S 54 W	S 73 W	S 74 W	S 71 W	S 73 W	S 75 W	N 66 W	N 1 E
N 24 W	N 5 W	N 53 E	N 77 W	S 86 W	N 62 W	N 58 W	N 60 W	N 59 W	N 65 W	N 41 W	N 22 W
N 52 E	N 61 E	N 77 E	S 33 W	S 44 W	S 49 W	S 55 W	S 50 W	S 49 W	S 48 W	S 38 E	N 59 E
S 84 E	S 69 E	S 53 E	S 43 W	S 58 W	S 67 W	S 67 W	S 61 W	S 63 W	S 61 W	S 45 W	S 86 E
S 63 E	S 58 E	S 56 E	S 48 E	N 74 W	N 57 W	N 57 W	N 60 W	N 60 W	N 60 W	S 66 E	S 63 E
N 24 E	N 34 E	N 66 E	N 80 E	S 85 E	S 7 E	S 31 E	S 66 E	S 69 E	N 77 E	N 28 E	N 23 E
N 43 E	N 57 E	S 78 E	S 54 E	S 32 W	S 51 W	S 50 W	S 52 W	S 51 W	S 51 W	N 23 E	N 28 E
N 23 W	N 27 W	N 58 W	S 75 W	S 33 W	S 2 E	S 4 E	S 1 E	S 9 E	S 35 E	N 6 W	N 15 W
N 43 E	S 47 E	S 27 E	S 1 E	S 4 E	S 4 E	S 1 E	S 2 E	S 12 E	S 33 E	N 16 E	N 21 E
N 24 W	N 10 W	S 19 E	S 22 E	S 25 E	S 25 E	S 22 E	S 15 E	S 4 E	S 87 W	N 32 W	N 29 W
N 2 E	N 50 W	N 59 W	N 69 W	S 77 W	S 15 W	S 27 W	S 33 W	S 26 W	S 64 E	N 54 E	N 31 E
N 11 E	N 26 W	N 39 W	N 57 W	S 81 W	S 30 W	S 43 W	S 40 W	S 44 W	S 56 E	N 61 E	N 37 E
N 25 E	S 56 W	S 22 W	S 19 W	S 18 W	S 16 W	S 29 W	S 36 W	S 23 W	S 46 E	N 57 E	N 36 E
N 25 E	N 12 W	S 56 W	S 58 W	S 47 W	S 19 W	S 33 W	S 34 W	S 34 W	N 69 E	N 58 E	N 57 E
N 10 W	N 39 W	N 55 W	N 59 W	S 73 W	S 46 W	S 61 W	S 58 W	S 59 W	S 75 W	N 20 E	N 27 E
N 39 E	N 41 E	N 56 E	N 84 E	S 34 W	S 38 W	S 44 W	S 43 W	S 43 W	S 5 W	N 63 E	N 51 E
S 87 E	N 80 E	N 86 E	S 56 E	S 43 W	S 43 W	S 44 W	S 46 W	S 50 W	S 39 W	S 39 E	S 78 E
NE	NE	NE	NNE	SSW	S	SSW	SSW	SW	WSW	N	NE
N 6 W	N 16 W	N 47 W	N 63 W	N 56 W	N 57 W	N 72 W	N 71 W	N 51 W	N 35 W	N 9 W	N 5 E
N 79 E	N 76 E	N 73 E	N 78 E	S 79 E	S 11 E	S 13 E	S 13 E	S 28 E	N 82 E	N 88 E	N 83 E
NW	NW	NW	var.	SE	SE	SE	SE	SE	SE	SE	NW
NW	NW	NW	SE	SE	SE	SE	SE	SE	ENE	NE	var.
N 80 E	N 76 E	N 71 E	E 45 S	S 43 W	S 29 W	S 38 W	S	N 69 E	N 44 E	N 52 E	N 84 E
SE	ESE	E	E	ESE	ESE	SE	SE	WSW	ENE	ENE	ENE
E	ENE	E	E	SSE	SW	SSW	var.	ESE	ESE	SSW	E
SSW	SSW	S	ENE	var.	WNW	WNW	WNW	WSW	WSW	WSW	WSW
ESE	SSW	SW	SW	SW	SW	SSW	SW	SSW	SW	SW	ENE
WNW	ESE	NW	E	E	E	E	E	E	E	E	WNW
WNW	WNW	NNE	NNE	NE	ENE	NE	NNW	WNW	W	W	WNW
S	S	SE	SE	SE	ESE	E	var.	SE	SE	SSE	S
SE	E	E	NNW	WNW	WNW	W	WNW	WNW	W	SSE	S
SE	SE	SE	SE	SSE	SSE	var.	var.	SSE	SE	SE	SE
S 33 E	S 58 E	N 74 E	S 71 E	S 77 E	N 68 W	S 64 E	S 88 W	S 53 W	S 80 E	S 86 E	S 52 E
S 50 E	S 63 E	N 21 E	S 62 E	S 70 E	N 80 W	S 17 E	W	S 45 W	N 85 E	S 82 E	S 58 E
N 44 E	N 45 E	N 41 E	E 23 N	N 32 W	E 42 S	W	W 10 N	N 26 W	N 43 E	N 45 E	N 43 E
E 3 N	E 16 N	E 14 S	E 36 S	S 25 E	S 15 E	S 23 W	S 14 E	E 25 S	E 6 N	E 20 N	E 7 N
E 14 N	E 13 N	E 4 N	E 4 N	E 11 S	E 51 S	E 46 S	E 72 S	E 12 N	E 15 N	E 28 N	E 26 N
S 70 W	S 70 W	S 76 W	N 48 E	E 52 S	E 59 S	E 62 S	E 64 S	E 60 S	E 87 S	E 88 S	S 59 W
E 88 S	E 45 S	E 29 S	E 51 S	E 55 S	E 70 S	E 76 S	E 72 S	E 72 S	E 81 S	E 72 S	E 82 S
W 7 N	W 20 N	W 30 N	N 20 E	N 79 E	N 85 E	E 6 S	E 21 S	E 18 S	E 25 S	E 30 W	W 4 N
NE	N	ENE	E	SE	S	NW	NW	NW	SE	NE	ENE
W 50 N	W 45 N	W 44 N	W 43 N	W 42 N	W 23 N	W 21 N	S 79 W	W 15 N	W 38 N	W 43 N	W 52 N
S 38 W	S 44 W	S 46 W	S 46 W	S 44 W	S 45 W	S 43 W	S 45 W	S 45 W	S 45 W	S 43 W	S 44 W
NE	NE	E	var.	E	SE	SE	SE	var.	var.	NE	NE
N 27 E	N 25 E	N 39 E	S 12 W	S 17 W	S 10 W	S 2 W	S 6 W	S 12 W	S 9 W	S 6 W	N 23 E
NE	NE	NE	SW	SW	SW	SW	SW	SW	NE	NE	NE
S 37 E	S 13 W	S 4 W	S 35 W	S 45 W	S 24 W	S 86 W	S 66 E	S 67 E	S 27 W	S 11 E	S 21 E
N 46 E	N 34 E	N 52 E	N 53 E	N 45 E	S 45 W	S 43 W	N 35 E	N 42 E	N 48 E	N 45 E	N 45 E

Place.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. ° ′	Longitude. ° ′	Height, Feet.
Van Rensseller, .	Arctic Regions	$1\frac{1}{2}$	1853–55	two hourly	78 37	–70 53	0
Northumberland Sd.,	do.	1	1852–53	do.	76 52	–97 0	0
Wellington Channel,	do.	1	1852–53	do.	75 37	–92 22	0
Beechy Island, .	do.	2	1852–54	four hourly	74 43	–91 54	0
Griffith's Island, .	do.	1	1850–51	two hourly	74 34	–95 20	0
Port Leopold, .	do.	1	1848–49	do.	73 50	–90 12	0
Port Kennedy, .	do.	1	1858–59	do.	72 1	–94 14	0
Gulf of Boothia, .	do.	$2\frac{1}{2}$	1829–32	hourly	70 6	–91 45	0
Melville Sound, .	do.	$\frac{2}{3}$	1853–54	two hourly	74 42	–101 22	0
Cambridge Bay, .	do.	1	1852–53	four hourly	69 3	–105 12	0
Walker Bay, .	do.	1	1851–52	do.	71 35	–117 39	0
Princess Royal Is.,	do.	1	1850–51	do.	72 47	–117 35	0
Mercy Bay, . .	do.	$1\frac{2}{3}$	1851–53	do	74 6	–117 55	0
Dealy Island, .	do.	1	1852–53	do.	74 56	–108 49	0
Camden Bay, .	do.	1	1853–54	do.	70 8	–145 29	0
Port Providence, .	do.	$\frac{3}{4}$	1848–49	hourly	64 26	–173 0	0
Chamisso, . .	do.	1	1849–50	do.	66 13	–161 46	0
Port Clarence, .	do.	3	1850–54	do.	65 17	–166 20	0
Point Barrow, .	do.	2	1852–54	six hourly	71 21	–156 17	10
Norway House, .	Dominion of	7	1841–47	?	54 0	–98 0	700
Sydney, . .	Canada	10	1874–83	*	46 8	–60 10	28
Halifax, . .	do.	10	do.	*	44 39	–63 36	122
Parry Sound, .	do.	9	1875–83	*	45 19	–80 0	641
Fort Garry, . .	do.	10	1874–83	*	49 53	–97 7	758
Mazatlan, . .	Mexico	6	1880–85	various	23 11	–106 17	25
Manaos, . .	The Amazon	?	?	9 : 3	–3 8	–60 0	121

* At 6.50, 2.50, 10.50, Toronto time.

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
°	°	°	°	°	°	°	°	°	°	°	°
S 15 W	S 9 E	SEE	S 25 W	S 27 W	N 48 W	S 47 W	S 1 E	S 40 W	S 17 W	S 6 W	S 18 E
S 2 E	N 60 E	S 44 E	N 8 E	N 20 W	N 4 W	S 16 W	S 70 E	S 10 E	N 25 W	S 73 E	N 68 E
S 32 E	S 11 E	S 38 E	S 20 E	S 14 W	N 75 E	S 81 E	N 46 E	S 28 W	S 35 E	S 17 E	S 37 E
N 12 E	N 32 E	N 52 E	N 18 E	N 31 W	N 22 W	S 88 E	N 68 W	N 15 E	N 12 E	N 60 E	N 10 E
N 46 W	N 57 W	N 45 W	S 51 W	N 69 W	S 60 W	S 53 W	N 46 W	S 50 W	N 53 W	S 53 E	N 57 W
N 26 W	N 43 W	N 35 E	N 13 E	N 10 E	N 48 E	N 20 W	N 14 W	N 52 E	N 18 E	N 24 W	N
N 11 W	N 67 W	N 23 W	N 11 E	N 12 W	N 12 W	N 32 W	N 11 E	N 12 W	N 6 W	N 12 W	N 45 W
N 34 W	N 46 W	N 49 W	N 32 W	N 18 W	N 66 W	N 10 W	N 25 W	N 18 W	N 49 W	N	N 38 W
N 44 W	N 46 W	N 23 W	S 18 W	N 35 W	...	...	...	N 53 W	N 65 W	N 34 W	N 24 W
N 60 W	N 6 W	N 63 E	N 17 E	N 29 W	N 9 W	N 58 W	N 69 W	N 54 W	N 26 E	S 40 E	N 24 W
N 12 E	N 1 W	N 36 E	N 68 E	N 49 E	N 47 W	N 26 W	N 20 E	N 32 E	N 54 E	N 78 E	S 53 W
N 54 W	N 83 W	N 86 W	N 33 W	N 88 W	N 88 E	N 29 W	S 77 W	S 77 W	N 41 E	N 70 E	N 62 W
S 54 W	N 57 W	S 66 W	S 56 E	N 46 W	N 46 W	N 44 W	N 46 W	N 66 W	S 22 W	N 43 W	N 86 W
N 5 W	N 6 E	N 21 E	N	N 15 W	N 20 W	N 7 W	N 25 W	N 16 W	N 13 W	N 21 E	N 4 E
W	N 88 W	N 77 W	N 43 E	N 88 E	N 75 E	S 83 E	...	N 85 E	N 20 W	N 86 W	N 81 E
N 84 W	S 50 E	N 9 W	N 8 E	N 49 E	N 45 E	...	...	...	N 24 E	N 23 E	N 10 E
N 74 W	S 78 W	S 24 W	S 50 E	N 86 W	S 81 W	S 40 W	N 82 W	N 74 E	S 67 E	N 54 E	N 30 E
N 68 E	N 56 E	N 53 E	N 50 E	N 46 E	S 80 W	N 74 W	...	N 46 E	N 26 E	N 43 E	N 57 E
N 88 W	N	N 82 E	S 88 E	N 82 E	N 89 E	N 60 E	N 67 E	N 52 E	N 66 E	S 88 E	S 14 E
S 81 W	N 13 E	N 31 E	N 65 E	S 78 E	S 19 E	S 48 E	S 65 W	S 71 W	N 3 W	N 37 E	S 32 W
N 89 W	N 83 W	N 73 W	N 67 W	S 75 W	S 52 W	S 47 W	S 44 W	S 62 W	S 70 W	S 88 W	N 86 W
N 76 W	N 61 W	N 57 W	N 67 W	N 74 W	S 60 W	S 62 W	S 75 W	N 84 W	N 77 W	N 78 W	N 59 W
S 21 W	S 44 W	N 15 E	S 18 W	S 65 E	S 11 W	S 85 W	S 76 W	S 74 W	S 51 W	S 11 W	N 47 W
S 82 W	N 81 W	N 66 W	N 22 E	N 87 E	N 69 E	S 56 W	S 50 W	S 75 W	N 72 W	N 64 W	N 89 W
SW	SW	SW	SW	SW	E	E	E	SE	SE	SW	SW
NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	NW

TABLE IX.

Showing the Mean Monthly and Annual Temperature (Fahrenheit) at Different Places over the Globe.

Note.—Under Column of "Hours of Observation," the A.M. Observations are placed before the colon [:], the P.M. after it. The means in the Table are the arithmetic means for the times of observation. The expression 7 : 1, 9, 9 signifies that, in striking the means, the observations at 9 P.M. have been taken twice; and m, 8 : 2, 8 that the means are the averages of the daily Minimum, 8 A.M., and 2 and 8 P.M., &c. In the same column "M.m." signifies that the Mean Temperature is deduced from the Maximum (M) and Minimum (m) Observations, "M.T." that the Means have been reduced to Approximate Mean Temperatures. A Minus sign before Latitudes indicates Latitude South, and before Longitudes, Longitude West. In the last column are entered the corrections which have been applied in constructing the Table.

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Malin Head, . .	Ireland	15	1870–84	M.m.	55 23	−7 22	230
Greencastle, . .	do.	15	do.	do.	55 12	−7 2	70
Londonderry, .	do.	15	do.	do.	55 0	−7 19	93
Lissan, . .	do	15	do.	do.	54 41	−6 45	305
Donaghadee, .	do.	15	do.	do.	54 38	−5 34	30
Belfast, . .	do.	15	do.	do.	54 36	−5 56	66
Aghalee, . .	do.	15	do.	do.	54 31	−6 16	130
Milltown, . .	do.	15	do.	do.	54 23	−6 16	200
Armagh, . .	do.	15	do.	hourly	54 21	−6 39	207
Brooksborough, .	do.	15	do.	M.m.	54 21	−7 22	239
Mullaghmore, .	do.	15	do.	do.	54 28	−8 28	40
Markree, . .	do.	15	do.	do.	54 11	−8 27	131
Belmullet, . .	do.	15	do.	do.	54 13	−10 0	40
Edgeworthstown, .	do.	15	do.	do.	53 42	−7 36	265
Athlone, . .	do.	15	do.	do.	53 25	−8 0	304
Parsonstown, .	do.	15	do.	do.	53 6	−7 55	182
Curragh Camp, .	do.	15	do.	do.	53 9	−6 49	450
Dublin, . .	do.	15	do.	do.	53 22	−6 21	158
Kingstown, . .	do.	15	do.	do.	53 17	−6 8	50
Monkstown, . .	do.	15	do.	do.	53 18	−6 8	110
Waterford, . .	do.	15	do.	do.	52 15	−7 6	100
Buttevant, . .	do.	15	do.	do.	52 14	−8 40	300
Foynes, . .	do.	15	do.	do.	52 37	−9 7	108
Roche's Point, .	do.	15	do.	do.	51 47	−8 19	32
Killarney, . .	do.	15	do.	do.	52 4	−9 30	90
Valentia, . .	do.	15	do.	do.	51 55	−10 18	23
North Unst, . .	Scotland	15	do.	9 : 9	60 51	−0 53	230
Bressay, . .	do.	15	do.	do.	60 6	−1 8	105
Dunrossness . .	do.	15	do.	M.m.	59 55	−1 20	126
Start Point, . .	do.	15	do.	9 : 9	59 17	−2 22	83
Sandwick, . .	do.	15	do.	M.m.	59 2	−3 18	94
Pentland Sk., .	do.	15	do.	9 : 9	58 41	−2 55	170
Wick, . . .	do.	15	do.	M.m.	58 27	−3 5	77
Holborn Head, .	do.	15	do.	9 : 9	58 37	−3 32	75
Dunrobin, . .	do.	15	do.	M.m.	57 59	−3 56	16
Lairg, . . .	do.	15	do.	do.	58 1	−4 22	458
Cape Wrath, .	do.	15	do.	9 : 9	58 38	−5 0	400
Scourie, . .	do.	15	do.	do.			45
Butt of Lewis, .	do.	15	do.	do.	58 31	−6 16	170
Stornoway, . .	do.	15	do.	M.m.	58 13	−6 23	70
Ushinish, . .	do.	15	do.	9 : 9	57 18	−7 12	176
Monach, . .	do.	15	do.	do.	57 32	−7 14	150
Barra Head, . .	do.	15	do.	do.	56 47	−7 39	683
Skerryvore, . .	do.	15	do.	do.	56 19	−7 7	150
Dhuheartach, .	do.	15	do.	do.	56 8	−6 38	145
Rona, . . .	do.	15	do.	do.	57 35	−5 57	222
Glencarron, . .	do.	15	do.	M.m.	57 30	−5 14	504
Culloden, . .	do.	15	do.	do.	57 29	−4 8	104
Roy Bridge, . .	do.	15	do.	do.	56 54	−4 48	310
Gordon Castle, .	do.	15	do.	do.	57 37	−3 5	104

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
41·8	41·6	42·6	45·7	50·2	53·9	56·8	57·9	54·3	49·4	44·0	42·2	48·3	...
39·5	40·4	41·9	46·0	50·5	55·5	58·3	58·1	54·3	48·0	42·8	39·3	47·9	...
40·5	41·8	43·0	46·9	51·0	56·2	58·6	58·8	54·6	48·6	42·8	40·2	48·6	...
38·0	39·8	40·8	45·2	49·6	55·0	57·4	58·0	53·3	47·4	41·5	38·0	47·0	...
40·2	41·3	42·3	46·0	50·1	55·0	57·8	58·1	54·3	49·0	43·5	40·3	48·2	...
40·0	41·0	42·4	46·8	50·9	56·9	59·1	58·9	54·3	47·8	42·8	39·5	48·4	...
38·7	40·8	42·0	46·9	51·0	57·0	59·2	59·0	54·7	48·5	42·3	38·8	48·2	...
39·4	40·3	42·8	47·2	50·7	56·1	58·7	58·5	54·1	48·2	42·3	39·0	48·1	...
39·8	41·2	42·2	46·0	50·3	55·5	58·0	58·0	53·6	48·0	42·4	38·8	47·8	...
39·2	40·6	41·7	46·0	49·8	54·8	57·5	58·0	53·3	47·6	42·0	38·6	47·4	...
42·5	42·6	43·9	47·8	51·7	56·6	59·1	59·3	55·8	50·3	45·1	42·0	49·7	...
39·7	41·6	42·5	46·6	50·3	55·0	58·3	58·2	54·2	48·6	43·0	39·0	48·1	...
43·0	42·8	44·1	47·5	51·2	54·9	57·2	58·0	55·3	49·8	45·1	43·0	49·3	...
39·3	40·4	42·0	46·0	50·2	55·7	58·2	58·7	54·0	47·5	42·4	39·0	47·8	...
38·4	40·5	42·7	46·7	51·5	57·2	59·4	59·1	54·2	48·3	41·8	38·5	48·2	...
40·2	41·9	43·2	47·0	51·8	56·7	59·4	59·4	54·9	48·5	42·8	39·0	48·7	...
38·1	40·8	41·6	45·8	50·4	56·2	59·0	58·0	54·3	48·0	42·0	38·8	47·8	...
40·4	42·2	43·1	46·3	51·2	56·1	59·2	59·5	54·8	49·0	43·8	40·0	48·8	...
42·0	43·5	44·3	46·8	51·6	56·8	60·0	59·8	56·0	50·2	45·0	42·7	49·9	...
41·3	42·8	43·9	47·6	52·2	57·4	60·0	59·6	55·6	49·2	43·9	40·3	49·5	...
41·8	42·7	43·3	47·4	51·3	57·3	60·0	59·7	55·0	49·5	44·5	41·4	49·5	...
40·1	42·2	43·9	47·7	52·4	58·2	60·0	59·5	55·0	48·7	43·1	40·0	49·2	...
42·0	42·9	45·2	48·2	52·3	56·3	58·3	58·5	55·6	50·2	44·8	42·0	49·7	...
43·8	44·1	45·0	48·4	53·6	58·2	60·7	60·7	56·8	51·2	46·3	43·5	51·0	...
43·3	43·6	44·6	47·5	51·6	56·2	59·3	59·5	55·1	49·8	45·7	42·4	49·9	...
45·3	45·5	46·3	49·0	52·8	56·3	58·7	59·5	56·6	52·0	47·6	45·4	51·3	...
39·8	39·4	38·9	42·0	45·3	50·0	52·3	53·0	50·7	46·1	41·8	40·7	45·0	...
40·7	39·9	39·6	42·5	45·5	50·4	54·0	54·6	51·5	47·4	43·2	40·9	45·8	...
39·6	39·4	39·2	42·3	45·8	50·5	54·0	54·5	51·4	46·6	41·8	39·5	45·4	...
40·7	40·2	40·3	43·0	46·6	51·0	54·7	55·1	52·6	48·2	43·7	40·9	46·4	...
39·5	39·3	39·7	42·9	46·8	52·1	55·4	55·2	52·1	47·1	41·7	39·2	45·9	...
39·8	39·8	39·6	42·3	45·8	50·8	54·1	54·3	51·9	47·8	42·8	40·1	45·7	...
38·7	39·5	40·8	44·1	48·3	53·2	56·6	56·1	52·6	47·2	41·5	38·6	46·4	...
38·6	39·0	39·8	43·5	47·3	51·9	55·5	55·7	52·5	47·3	42·1	39·0	46·0	...
38·2	39·5	40·6	44·2	48·4	53·3	56·5	56·4	52·5	47·0	41·4	37·9	46·3	...
35·8	36·9	39·1	43·2	48·1	53·4	56·4	55·7	51·5	45·5	38·8	35·6	45·0	...
38·5	38·4	38·8	42·2	45·4	50·6	53·4	53·6	50·3	46·0	41·1	39·6	45·6	...
39·0	38·9	39·7	44·3	48·1	54·1	56·3	56·3	52·0	46·6	41·1	38·8	46·3	...
40·7	40·4	40·7	43·7	46·8	51·2	54·3	55·2	52·1	47·7	43·2	40·9	46·4	...
38·8	39·7	40·4	44·0	47·6	52·4	55·2	55·2	51·6	46·2	41·5	38·7	45·9	...
41·6	41·3	41·8	44·9	48·3	52·6	55·3	56·1	52·9	48·8	44·2	41·9	47·5	...
43·0	43·0	43·1	46·0	49·4	54·0	56·7	57·4	54·4	50·0	45·5	43·3	48·8	...
40·4	40·3	40·2	43·5	47·1	51·3	53·6	54·5	51·4	46·9	42·6	40·8	46·1	...
42·5	42·3	42·3	45·0	48·3	52·7	55·1	56·2	53·7	49·7	43·2	43·0	48·0	...
42·2	41·8	42·2	45·0	48·2	52·7	55·1	56·3	53·8	49·8	45·2	42·7	47·9	...
40·7	40·4	40·5	44·2	47·5	52·5	55·1	55·5	52·3	47·7	42·9	40·9	46·6	...
36·8	37·8	39·3	43·3	47·8	52·3	55·2	55·7	51·4	45·0	39·7	36·8	45·1	...
37·7	39·2	40·6	44·2	48·9	54·3	57·6	57·0	52·8	46·9	40·3	37·3	46·4	...
37·0	38·2	39·5	44·8	49·1	54·6	56·5	56·4	51·5	45·9	39·5	36·8	45·8	...
37·8	39·2	40·7	44·5	48·4	54·7	57·9	57·6	53·5	47·1	41·0	37·6	46·7	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
New Pitsligo, .	Scotland	15	1870–84	M.m.	57 36	−2 12	495
Braemar, . .	do.	15	do.	do.	57 0	−3 24	1114
Aberdeen, . .	do.	15	do.	do.	57 19	−2 6	66
Dundee, . .	do.	15	do.	do.	56 28	−2 56	164
Dalnaspidal, . .	do.	15	do.	do.	56 50	−4 13	1414
Ochtertyre, . .	do.	15	do.	do.	56 23	−3 53	333
Stronvar, . .	do.	15	do.	do.	56 21	−4 20	422
Dollar, . . .	do.	15	do.	do.	56 10	−3 4	178
Bell Rock, . .	do.	15	do.	9 : 9	56 26	−2 23	93
Isle of May, . .	do.	15	do.	do.	56 11	−2 33	240
Ardnamurchan, .	do.	15	do.	do.	56 44	−6 13	180
Airds, . . .	do.	15	do.	do.	56 33	−5 25	15
Rhinns of Islay, .	do.	15	do.	do.	55 40	−6 31	150
Callton Mor, .	do.	15	do.	M.m.	56 8	−5 30	135
Eallabus, . .	do.	15	do.	do.	55 45	−6 18	71
Mull of Kintyre, .	do.	15	do.	9 : 9	55 19	−5 48	297
Rothesay, . .	do.	15	do.	M.m.	55 50	−5 4	116
Ardrossan, . .	do.	15	do.	do.	55 38	−4 49	16
Pinmore, .	do.	15	do.	do.	55 12	−4 49	190
Glasgow, .	do.	15	do.	do.	55 53	−4 18	184
Lanark, . .	do.	15	do.	do.	55 41	−3 47	630
Edinburgh, . .	do.	15	do.	do.	55 56	−3 10	270
N. Esk Reservoir, .	do.	15	do.	do.	55 48	−3 21	1150
East Linton, .	do.	15	do.	do.	55 59	−2 39	90
Marchmont, . .	do.	15	do.	do.	55 44	−2 25	500
Wolfelee, . .	do.	15	do.	do.	55 22	−2 39	601
Drumlanrig, .	do.	15	do.	do.	55 16	−3 48	191
Cargen, . .	do.	15	do.	do.	55 2	−3 37	85
Corsewall, . .	do.	15	do.	9 : 9	55 0	−5 9	112
Mull of Galloway, .	do.	15	do.	do.	54 38	−4 51	325
Point of Ayre, .	Isle of Man	15	do.	do.	54 25	−4 22	106
Langness, . .	do.	15	do.	do.	54 3	−4 35	38
Shields, . .	England	15	do.	M.m.	55 0	−1 27	124
Durham, . .	do.	15	do.	do.	54 46	−1 35	335
Carlisle, . .	do.	15	do.	do.	54 53	−2 25	114
Scarborough, .	do.	15	do.	do.	54 18	−0 24	130
Barrow-in-Furness,	do.	15	do.	do.	54 7	−3 11	60
Leeds, . . .	do.	15	do.	do.	53 48	−1 33	137
York, . . .	do.	15	do.	do.	53 58	−1 5	50
Hull, . . .	do.	15	do.	do.	53 45	−0 20	12
Spurnhead, . .	do.	15	do.	do.	53 34	0 7	28
Blackpool, . .	do.	15	do.	do.	53 49	−3 3	31
Stonyhurst, . .	do.	15	do.	do.	53 51	−2 28	391
Bidstone Observ., .	do.	15	do.	do.	53 23	−3 7	197
Cheadle, . .	do.	15	do.	do.	52 28	−1 57	646
Chester, . .	do.	15	do.	do.	53 12	−2 54	65
Shrewsbury, .	do.	15	do.	do.	52 45	−2 57	266
Llandudno, . .	do.	15	do.	do.	53 21	−3 50	100
Holyhead, . .	do.	15	do.	do.	53 18	−4 39	44
Churchstoke, .	do.	15	do.	do.	52 31	−3 5	548

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
35·3	36·7	38·0	41·9	46·6	52·2	55·8	55·2	51·3	45·1	39·2	35·2	44·4	...
33·8	35·2	36·9	41·2	45·8	52·0	55·1	54·1	49·5	43·3	36·9	33·6	43·2	...
37·8	39·3	40·5	45·2	48·8	54·4	58·1	57·4	53·3	47·2	41·3	37·5	46·7	...
36·9	37·7	40·1	44·3	49·4	55·4	58·8	58·1	53·6	46·8	40·3	36·5	46·5	...
32·5	33·2	34·4	39·2	44·6	50·7	54·0	53·1	48·1	41·8	35·8	32·6	41·7	...
35·6	37·0	38·9	43·5	48·8	54·9	57·8	57·1	51·8	45·5	39·1	35·4	45·5	...
36·5	37·6	39·0	43·8	48·8	54·7	57·6	56·7	52·0	45·3	39·4	36·1	45·6	...
37·2	38·6	40·1	44·6	49·4	52·2	58·2	57·6	53·0	46·1	40·6	37·0	46·2	...
39·4	39 4	40·5	43·2	47·8	53·5	57·2	56·9	53·8	48·7	43·3	39·7	46·9	...
38·7	39·1	39·8	42·9	47·9	53·4	57·0	56·9	53·5	48·2	42·4	39·1	46·6	...
41·6	41·2	41·5	44·8	48·3	53·1	55·5	56·4	53·4	48·9	44·2	41·8	47·6	...
39·4	39·7	40·8	45·3	49·3	54·5	56·8	56·7	53·1	47·3	42·2	39·8	47·1	...
42·1	41·6	42·1	45·2	49·0	53·5	55·7	57·0	54·4	49·7	44·8	42·6	48·1	...
38·6	39·3	40·6	44·7	49·2	55·1	57·4	57·6	53·3	47·0	41·3	38·3	46·9	...
40·0	40·5	41·6	45·2	49·1	54·2	56·6	56·9	53·3	48·2	42·9	39·7	47·4	...
41·1	40·9	41·4	44·9	48·8	53·7	56·3	57·3	54·2	49·1	43·9	41·6	47·8	...
39·1	399	41·0	45·7	50·1	56·0	58·3	58·1	53·8	47·9	42·3	39·2	47·7	...
39·5	40·6	41·8	45·0	49·2	54·8	57·8	58·0	53·8	48·2	42·9	39·7	47·6	...
38·8	40·0	41·0	45·1	49·7	55·0	58·1	57·8	53·1	47·1	41·8	38·7	47·2	...
38·0	39·4	40·5	44·9	49·5	55·3	58·1	57·7	53·4	46·9	40·9	37·8	46·9	...
35·2	37·1	38·5	43·1	48·0	54·0	56·7	56·3	52·2	45·5	38·5	34·8	45·0	...
37·3	39·1	40·2	44·5	48·8	54·9	58·0	57·5	52·9	46·1	40·2	36·9	46·4	...
34·1	35·5	36·4	40·6	45·2	51·5	54·4	54·1	49·9	43·7	37·3	34·1	43·1	...
37·7	39·2	40·8	44·7	49·4	55·3	58·8	58·0	53·7	47·3	41·2	37·3	47·0	...
36·2	37·4	39·4	43·4	48·0	54·0	57·7	57·0	52·5	46·1	39·8	36·0	45·6	...
36·0	37·6	39·0	43·9	48·2	54·4	57·8	56·7	51·6	45·0	38·9	35·7	45·4	...
37·5	39·2	40·6	45·3	49·6	55·5	58·5	58·0	52·9	46·6	40·2	36·9	46·7	...
38·0	39·7	40·4	45·3	49·7	55·8	58·5	58·1	54·0	47·3	41·1	37·9	47·2	...
40·6	40·9	41·5	45·0	49·0	54·0	56·6	57·3	53·9	49·4	44·1	41·1	47·7	...
40·3	40·2	40·6	44·4	48·3	53·3	56·3	57·2	54·4	49·2	43·8	41·0	47·4	...
41·6	41·7	42·0	45·0	49·0	54·3	57·6	58·1	55·4	50·4	45·3	42·3	48·6	...
42·1	42·1	42·3	45·6	49·2	54·5	58·3	58·0	56·1	51·0	45·8	42·6	49·0	...
38·6	39·9	41·2	44·7	49·0	55·0	59·0	58·1	54·2	48·3	42·3	38·5	47·4	...
37·3	39·0	40·5	44·6	48·5	55·7	60·0	59·3	54·0	47·0	40·9	36·9	47·0	...
37·7	39·8	41·4	46·2	50·6	56·9	59·9	59·1	54·6	47·6	40·6	37·0	47·6	...
38·8	40·2	41·5	45·7	50·2	56·1	60·3	59·7	55·7	49·6	42·8	39·0	48·3	...
39·4	40·4	42·2	46·8	51·6	56·9	59·6	59·7	56·4	49·9	43·6	39·8	48·9	...
38·7	40·4	42·0	46·3	52·0	58·2	61·8	61·0	56·3	48·9	42·1	38·2	48·8	...
37·7	39·7	41·5	46·2	51·4	57·4	61·3	60·8	56·2	48·6	41·9	37·7	48·4	...
37·5	39·6	41·3	46·0	50·6	57·2	61·3	60·5	55·7	48·7	41·8	37·3	48·2	...
39·0	39·6	41·5	45·4	49·8	56·1	60·9	60·4	56·6	50·5	43·3	38·8	48·5	...
38·7	40·0	41·3	45·4	49·8	55·7	59·0	58·8	55·4	48·7	42·6	38·9	47·9	...
37·8	39·6	41·3	46·3	50·9	56·6	59·8	59·5	54·9	48·1	41·8	37·7	47·0	...
39·3	40·7	42·5	47·2	51·5	57·2	60·4	60·3	56·2	49·7	43·3	39·4	49·0	...
37·2	38·7	40·4	45·1	49·1	55·2	59·0	58·4	54·0	47·4	40·6	37·1	46·9	...
38·8	41·3	42·7	47·4	52·0	58·1	61·3	61·0	56·5	49·2	42·7	39·2	49·2	...
38·6	40·7	42·6	46·4	51·0	57·2	61·5	60·6	56·0	48·5	42·2	38·2	48·6	+1·0
41·9	42·6	43·9	47·8	52·2	57·7	60·7	61·2	57·1	51·0	45·1	41·7	50·2	...
42·3	42·3	43·5	47·3	51·2	56·7	59·8	59·9	56·4	51·3	45·7	42·4	49·9	...
38·5	40·1	41·4	45·6	50·1	56·3	59·7	59·4	54·7	47·9	42·0	38·2	47·8	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Lampeter,	England	15	1870–84	M.m.	52 7	−4 5	420
Pembroke,	do.	15	do.	do.	51 41	−5 30	150
Cardiff,	do.	15	do.	do.	51 23	−3 9	43
Carmarthen,	do.	15	do.	do.	51 52	−4 18	188
Ross,	do.	15	do.	do.	51 55	−2 35	213
Kelstern,	do.	15	do.	do.	53 24	−0 7	388
Hodsock,	do.	15	do.	do.	53 18	−1 8	56
Leicester,	do.	15	do.	do.	52 39	−1 8	237
Hillington,	do.	15	do.	do.	52 48	0 33	88
Holkham,	do.	15	do.	do.	52 57	0 46	39
Somerleyton,	do.	15	do.	do.	52 32	1 37	50
Royston,	do.	15	do.	do.	52 2	−0 1	269
Cardington,	do.	15	do.	do.	52 7	−0 29	100
Colchester,	do.	15	do.	do.	51 53	0 53	109
Rugby,	do.	15	do.	do.	52 12	−1 14	289
Oxford,	do.	15	do.	do.	51 46	−1 16	212
Gloucester,	do.	15	do.	do.	51 52	−2 14	100
Cheltenham,	do.	15	do.	do.	51 54	−2 3	184
Salisbury,	do.	15	do.	do.	51 4	−1 48	186
Strathfield Turgiss,	do.	15	do.	do.	51 20	−1 0	197
Greenwich,	do.	15	do.	do.	51 29	0 0	159
Ramsgate,	do.	15	do.	do.	51 20	1 25	105
CrowboroughBeacon,	do.	15	do.	do.	51 3	0 8	776
Brighton,	do.	15	do.	do.	50 49	−0 8	206
Osborne,	do.	15	do.	do.	50 45	−1 16	172
Clifton,	do.	15	do.	do.	51 28	−2 36	228
Taunton,	do.	15	do.	do.	51 1	−3 6	80
Ilfracombe,	do.	15	do.	do.	51 4	−4 7	25
Barnstaple,	do.	15	do.	do.	51 5	−4 3	43
Columpton,	do.	15	do.	do.	50 51	−3 23	202
Exeter,	do.	15	do.	do.	50 43	−3 31	164
Babbacombe,	do.	15	do.	do.	50 29	−3 31	293
Prawle Point,	do.	15	do.	do.	50 13	−3 44	350
Dartmoor,	do.	15	do.	do.	50 33	−3 59	1372
Bude,	do.	15	do.	do.	50 50	−4 37	16
Truro,	do.	15	do.	do.	50 17	−5 4	43
Falmouth,	do.	15	do.	do.	50 9	−5 4	211
Helston,	do.	15	do.	do.	50 7	−5 12	106
Scilly,	do.	15	do.	do.	49 55	−6 18	100
Guernsey,	Channel Isles	15	do.	do.	49 28	−2 32	204
Jersey,	do.	15	do.	do.	49 12	−2 7	50
Sydvaranger,	Norway	15	do.	m. 8 : 2, 8	69 40	30 11	67
Karasjok,	do.	15	do.	do.	69 19	25 55	438
Vardö,	do.	15	do.	do.	70 22	31 7	33
Kistrand,	do.	15	do.	do.	70 25	25 13	32
Gjaesvaer,	do.	15	do.	do.	71 7	25 22	22
Alten,	do.	15	do.	do.	69 58	23 17	43
Tromsö,	do.	15	do.	do.	69 39	18 58	50
Andenes,	do.	15	do.	do.	69 20	16 8	4
Lödingen,	do.	15	do.	do.	68 24	16 1	44

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
39·6	41·3	42·5	47·2	51·8	57·1	59·7	59·2	55·4	49·0	42·9	39·3	48·7	...
43·1	42·9	43·4	47·2	51·1	56·5	59·6	60·1	56·9	51·7	47·0	43·5	50·2	...
40·0	41·6	43·6	48·3	53·4	59·3	61·9	61·5	57·0	49·0	43·8	40·5	50·0	...
41·2	42·2	43·8	47·8	51·8	57·5	60·6	60·1	56·7	50·5	44·5	40·9	49·8	...
38·8	41·0	43·0	47·8	52·6	58·8	62·1	62·0	56·6	49·0	42·7	38·8	49·4	...
37·4	39·5	41·0	45·3	49·5	56·1	59·7	59·5	55·3	48·8	41·4	37·1	47·6	...
39·0	41·4	42·6	47·0	52·0	58·3	62·0	61·5	56·8	49·8	42·8	38·5	49·1	+1·3
38·6	40·5	42·3	46·9	51·4	57·8	61·4	60·8	56·2	49·4	42·4	38·3	48·8	...
37·8	39·9	42·0	46·9	51·4	58·4	62·0	51·1	56·3	49·4	42·1	37·6	48·7	...
38·1	39·8	41·8	46·6	51·4	57·7	62·3	61·3	56·4	49·8	43·0	38·4	48·9	+1·5
37·8	39·8	41·8	46·3	50·8	57·1	61·9	61·7	57·1	50·5	42·8	37·9	48·8	...
37·8	39·6	42·4	47·5	52·4	59·1	62·9	62·5	57·5	49·4	41·8	37·6	49·2	...
38·2	40·7	43·1	48·5	53·1	60·3	63·6	62·5	57·1	49·5	42·3	38·0	49·7	...
38·2	40·0	42·0	47·4	51·7	57·7	62·6	62·5	57·8	50·4	42·5	38·2	49·3	...
37·7	39·7	41·7	46·6	51·5	58·6	61·7	61·3	56·7	48·6	41·3	37·1	48·5	...
39·0	40·8	43·0	47·9	52·6	59·0	62·4	61·9	56·8	49·7	43·1	39·0	49·6	...
39·2	40·7	43·5	49·1	53·9	60·0	63·0	62·9	57·8	50·3	43·3	39·3	50·3	...
39·7	41·5	43·0	47·4	52·2	59·0	62·8	61·8	56·6	49·0	42·4	39·3	49·6	+1·3
38·5	40·8	43·8	48·1	53·2	59·5	62·9	62·5	57·1	49·5	42·4	38·4	49·7	...
38·5	40·6	43·4	48·1	52·5	59·0	63·1	62·3	57·4	50·1	43·0	38·1	49·7	...
38·8	40·4	42·3	48·2	54·0	60·4	63·6	63·3	58·5	50·9	43·0	39·9	50·3	...
39·4	40·7	43·2	47·9	52·3	58·2	62·5	62·6	58·6	51·5	43·8	39·6	50·0	...
36·8	38·4	41·8	45·5	50·3	57·1	61·2	61·0	56·1	48·9	41·6	37·3	48·0	...
39·8	40·6	42·6	47·7	52·6	59·4	62·8	62·7	58·1	50·8	43·7	39·6	50·0	...
39·8	39·6	43·8	48·5	53·7	59·8	63·5	63·7	59·0	51·5	44·4	39·9	50·8	...
39·7	41·3	43·2	48·3	52·8	59·0	62·4	62·0	57·0	50·0	43·3	39·8	49·9	...
40·3	41·8	43·6	48·7	53·1	58·7	63·2	62·8	57·6	51·0	44·3	40·3	50·4	...
42·6	43·4	44·5	47·6	51·8	56·7	59·7	60·6	57·6	52·2	46·7	42·8	50·5	+1·0
40·7	42·5	44·4	48·9	54·1	59·5	62·0	62·5	58·1	51·5	44·7	40·7	50·8	−1·5
40·6	42·6	44·0	48·3	53·0	58·5	61·7	61·5	57·3	50·5	44·4	40·8	50·3	+1 0
40·5	42·6	44·3	48·2	53·3	58·9	62·8	62·5	57·5	50·8	43·8	40·6	50·5	...
41·8	43·0	43·9	47·2	51·8	57·4	60·9	61·2	57·2	51·3	45·7	41·7	50·3	...
42·1	43·0	43·7	46·8	51·0	56·0	59·8	60·3	57·2	51·5	46·2	42·6	50·0	...
37·0	38·0	39·5	43·8	47·2	52·9	55·9	56·0	52·4	46·3	40·8	37·3	45·6	...
42·0	43·3	44·5	48·2	52·5	57·7	60·5	61·2	57·6	52·3	45·8	42·5	50·7	...
43·4	44·9	45·9	48·8	53·0	58·6	61·6	62·1	58·1	52·5	46·9	42·8	51·4	...
44·4	44·7	45·0	48·0	52·1	57·3	60·3	60·9	57·6	52·6	47·6	44·4	51·2	...
44·1	45·0	46·2	49·3	53·4	58·5	61·8	62·2	58·0	52·7	47·2	44·0	51·9	−1·0
46·2	46·3	46·2	48·7	52·6	57·6	60·9	61·4	58·5	53·8	49·4	46·4	52·3	...
43·0	44·6	45·0	48·4	52·4	57·1	60·9	61·7	58·9	53·6	48·4	43·7	51·5	...
42·1	43·4	45·2	49·5	53·2	58·4	62·3	63·0	59·5	53·7	47·6	43·1	51·8	...
13·0	10·0	16·1	24·9	34·5	45·3	52·4	50·7	42·4	32·6	20·9	13·2	28·9	...
2·4	1·0	12·6	24·2	35·5	48·0	54·1	51·8	41·7	29·0	11·9	4·2	26·4	...
22·8	21·0	23·5	28·4	34·0	41·6	47·1	47·7	42·6	34·9	27·5	22·8	32·7	...
20·4	17·5	21·7	27·8	35·8	46·4	52·2	51·4	43·7	35·0	26·6	21·3	33·3	...
25·0	23·0	24·1	28·2	35·1	42·9	48·6	48·2	42·8	35·7	27·4	24·6	33·8	...
19·2	17·0	20·6	28·7	38·1	47·3	53·9	52·0	43·7	33·1	22·3	16·9	32·8	...
26·4	24·9	26·2	31·0	38·2	47·0	51·8	50·2	44·0	36·1	29·1	26·1	36·0	...
30·0	27·2	28·5	32·0	38·7	45·4	50·5	51·0	45·8	38·6	32·6	29·0	37·4	...
28·0	25·9	27·5	32·2	40·2	49·0	54·8	53·0	46·5	38·3	31·6	27·6	37·9	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Fagerness,	Norway	15	1870–84	m. 8 : 2, 8	68 27	17 28	25
Röst,	do.	15	do.	do.	67 31	12 12	27
Bodö,	do.	15	do.	do.	67 17	14 24	15
Bronö,	do.	15	do.	do.	65 28	12 12	34
Christiansund,	do.	15	do.	do.	63 7	17 45	51
Aalesund,	do.	15	do.	do.	62 29	6 9	47
Florö,	do.	15	do.	do.	61 36	5 2	26
Leirdal,	do.	15	do.	do.	61 6	7 27	16
Röros,	do.	15	do.	do.	62 24	11 23	2064
Dovre,	do.	15	do.	do.	62 5	9 8	2110
Tönset,	do.	15	do.	do.	62 17	10 45	1617
Bergen,	do.	15	do.	do.	60 24	5 20	57
Skudesnes,	do.	15	do.	do.	59 9	5 16	13
Mandal,	do.	15	do.	do.	58 2	7 27	54
Sandösand,	do.	15	do.	do.	59 5	10 28	27
Christiania,	do.	15	do.	do.	59 55	10 43	81
Karesmando,	Sweden	15	do.	M.T.	68 26	22 30	1060
Jockmock,	do.	15	do.	do.	66 36	19 51	926
Haparanda,	do.	15	do.	do.	65 50	24 9	30
Piteå,	do.	15	do.	do.	65 19	21 30	34
Stensele,	do.	15	do.	do.	65 5	17 0	1106
Umeå,	do.	15	do.	do.	63 49	20 18	41
Husä,	do.	15	do.	do.	63 32	13 7	1260
Hernösand,	do.	15	do.	do.	62 38	17 58	45
Oestersund,	do.	15	do.	do.	63 11	14 38	972
Sweg,	do.	15	do.	do.	62 2	14 23	1050
Fahlun,	do.	15	do.	do.	60 36	15 37	380
Upsala,	do.	15	do.	do.	59 52	17 38	79
Stockholm,	do.	15	do.	do.	59 20	18 4	146
Carlstadt,	do.	15	do.	do.	59 23	13 30	179
Göteborg,	do.	15	do.	do.	57 42	12 59	22
Jönköping,	do.	15	do.	do.	57 47	14 11	321
Wisby,	do.	15	do.	do.	57 39	18 19	52
Kalmar,	do.	15	do.	do.	56 40	16 23	31
Carlshamn,	do.	15	do.	do.	56 10	14 52	31
Halmstad,	do.	15	do.	do.	56 40	12 52	34
Grimsey,	Iceland	15	do.	do.	66 34	−18 3	8
Akureyri,	do.	15	do.	do.	65 39	−18 10	8
Siglufjord,	do.	15	do.	do.	66 9	−18 57	[0]
Skagerstrand,	do.	15	do.	do.	65 50	−20 20	66
Flatey,	do.	15	do.	do.	65 22	−22 56	[0]
Stykkisholm,	do.	15	do.	do.	65 5	−22 46	37
Reykjavik,	do.	15	do.	do.	64 9	−22 0	23
Westmanö,	do.	15	do.	do.	63 26	−20 18	26
Berufjord,	do.	15	do.	do.	64 40	−14 15	59
Gjov,	Farö	15	do.	do.	62 21	−6 58	[0]
Myggenaes,	do.	15	do.	do.	62 9	−7 40	[0]
Thorshavn,	do.	15	do.	do.	62 2	−6 43	12
Kvalbö,	do.	15	do.	do.	61 39	−7 6	[0]
Skagen,	Denmark	15	do.	do.	57 44	10 38	10

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
25·9	23·3	26·1	32·1	40·4	49·2	54·6	52·6	45·3	37·3	29·3	24·9	36·7	...
32·7	30·7	31·4	35·5	40·3	46·3	51·3	51·4	47·6	41·5	35·7	31·6	39·7	...
29·1	26·4	29·4	34·2	41·7	50·1	55·3	54·1	47·9	39·4	31·8	28·0	39·0	...
31·5	29·3	32·0	36·6	43·5	51·1	56·0	55·7	50·4	41·9	34·7	30·2	41·0	...
34·5	33·7	34·6	39·1	45·1	52·8	56·5	56·4	50·6	44·3	37·6	34·3	43·3	...
35·8	34·8	36·0	40·5	45·5	52·9	56·3	56·1	52·1	45·2	39·0	35·6	44·1	...
35·1	33·9	34·9	40·3	46·2	53·6	57·4	56·8	51·6	44·8	38·4	34·4	43·9	...
29·0	29·1	32·4	41·6	50·0	58·6	61·6	59·0	51·1	41·8	34·0	27·9	43·0	...
11·0	12·3	18·1	28·5	38·8	50·0	52·6	50·5	42·6	31·8	20·1	10·8	30·6	...
16·0	16·3	22·1	30·7	40·3	51·3	54·0	51·9	43·6	33·0	22·4	15·1	33·1	...
8·8	11·5	19·6	31·1	41·7	52·8	55·0	52·5	44·2	32·0	18·8	8·2	33·0	...
34·0	32·3	34·9	41·7	47·8	55·3	58·5	57·6	52·3	44·3	37·5	33·2	44·2	...
35·5	34·2	35·4	41·2	46·4	53·5	58·2	58·0	54·0	46·7	40·2	33·9	44·7	...
31·7	30·5	33·6	40·5	48·2	57·0	61·0	59·5	53·6	45·2	37·1	31·3	44·1	...
29·3	27·8	31·4	39·2	48·5	57·9	62·1	60·7	54·3	44·5	36·2	29·7	43·5	...
24·3	23·7	29·3	39·2	49·6	60·1	62·8	60·4	52·2	41·1	32·1	23·7	41·6	...
7·6	4·0	10·8	23·3	35·0	48·9	55·0	51·4	42·6	28·4	12·5	7·4	27·2	...
6·6	6·0	17·2	29·4	39·9	53·4	58·2	53·8	43·6	30·4	17·3	6·7	29·3	...
11·8	10·5	18·5	27·6	38·5	52·5	58·8	54·7	45·9	34·5	19·5	10·8	32·0	...
15·8	13·8	21·8	31·0	40·9	53·9	60·1	56·8	47·6	35·3	21·6	14·0	34·4	...
11·4	10·7	20·3	31·0	41·7	53·4	59·1	54·3	44·4	32·9	18·3	8·8	32·3	...
17·6	15·8	21·8	31·1	41·5	53·5	58·2	55·4	47·2	36·2	24·8	16·1	35·0	...
17·3	16·6	22·0	31·3	39·7	50·9	55·4	53·4	46·6	34·7	25·9	19·1	34·4	...
20·5	18·0	26·1	33·5	42·7	53·8	59·2	57·0	49·5	39·0	29·1	20·0	37·4	...
16·3	16·1	22·4	31·5	41·2	53·3	57·1	54·6	46·6	36·0	25·7	15·9	34·8	...
13·3	12·0	22·5	32·0	43·2	55·6	57·9	54·3	45·9	33·8	22·8	12·3	33·8	...
21·7	20·0	25·7	35·5	46·5	58·4	61·8	58·1	50·4	38·9	29·7	19·9	38·9	...
25·0	22·9	27·9	36·5	46·3	57·2	61·5	58·5	51·1	41·0	31·8	24·0	40·3	...
27·3	26·1	29·1	36·7	46·3	57·4	62·0	59·5	52·6	42·1	33·6	27·1	41·7	...
27·2	25·0	29·9	37·6	49·1	59·3	62·9	61·2	53·2	42·6	34·2	25·9	42·4	...
31·3	29·9	33·3	41·0	50·4	59·0	62·8	61·3	54·9	45·3	37·4	31·0	44·8	...
28·6	27·3	30·7	38·4	48·2	57·0	62·1	59·9	52·5	42·8	35·4	29·3	42·6	...
31·5	29·3	31·5	37·4	45·7	51·9	61·5	60·1	53·3	45·3	38·1	32·2	43·2	...
30·6	29·3	31·9	38·8	48·0	57·7	62·7	61·5	55·6	46·0	37·4	31·1	44·2	...
29·8	28·4	31·8	38·5	49·2	59·0	63·0	61·4	55·3	46·1	38·6	30·1	44·3	...
31·5	30·0	32·9	40·5	49·8	59·2	61·8	60·7	54·0	44·8	36·7	30·7	44·4	...
27·1	26·8	25·8	29·5	35·8	41·7	45·2	45·6	42·2	37·0	32·6	29·5	34·9	...
27·3	26·3	25·0	32·1	39·4	46·8	49·8	48·3	44·0	36·7	32·4	27·8	36·3	...
27·5	26·4	24·8	30·0	36·7	44·3	47·4	47·0	42·8	35·6	30·4	28·1	35·1	...
25·4	25·3	25·2	30·0	38·4	46·2	48·1	47·0	42·7	36·6	28·8	27·3	35·1	...
27·6	27·8	27·5	33·0	40·4	47·6	51·2	50·2	45·4	38·0	33·2	30·6	37·7	...
27·8	28·0	27·6	33·4	39·8	46·2	49·4	48·8	44·4	38·0	33·0	29·2	36·8	...
29·3	29·5	29·4	37·7	43·6	50·6	53·5	51·7	46·3	39·7	33·5	31·0	39·7	...
35·0	34·5	36·0	39·6	44·3	49·4	52·1	50·9	46·3	41·3	36·8	35·4	41·8	...
28·8	28·7	28·8	33·8	39·0	44·4	47·3	47·0	43·9	38·4	33·3	30·2	37·0	...
38·2	38·4	38·3	42·2	46·0	50·4	52·6	52·9	49·3	45·0	40·0	38·0	44·3	...
38·8	38·8	38·6	42·1	45·3	49·8	51·6	52·0	48·9	44·7	40·5	38·6	44·1	...
38·0	38·3	38·1	41·4	44·7	49·1	51·7	51·8	48·6	44·2	39·6	37·6	43·6	...
39·9	39·9	40·3	44·2	46·7	51·1	53·3	53·4	50·2	45·7	41·3	39·8	45·5	...
32·8	30·9	34·3	41·9	49·7	57·6	62·6	61·8	55·8	48·6	40·6	32·7	45·8	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Vestervig,	Denmark	15	1870–84	M.T.	56 47	8 20	82
Fanö,	do.	15	do.	do.	55 27	8 24	18
Herning,	do.	15	do.	do.	56 8	8 58	195
Samsö,	do.	15	do.	do.	55 50	10 36	66
Copenhagen,	do.	15	do.	do.	55 41	12 36	44
Bogö,	do.	15	do.	do.	54 55	12 4	88
Hammershus,	do.	15	do.	do.	55 17	14 40	50
Groningen,	Holland	15	do.	8 : 8	53 13	6 34	49
Leeuwarden,	do.	15	do.	do.	53 12	5 47	24
Helder,	do.	15	do.	do.	52 57	4 40	0
Amsterdam,	do.	15	do.	do.	52 22	4 53	30
Utrecht,	do.	15	do.	do.	52 5	5 7	44
Hellevoetsluis,	do.	15	do.	do.	51 50	4 7	0
Flushing,	do.	15	do.	do.	51 26	3 35	0
Maestricht,	do.	15	do.	do.	50 52	5 37	174
Luxembourg,	do.	15	do.	do.	49 37	6 8	1020
Ostend,	Belgium	15	do.	M.m.	51 14	2 55	27
Brussels,	do.	15	do.	do.	50 51	4 22	186
Liège,	do.	15	do.	do.	50 41	5 33	199
Namur,	do.	15	do.	do.	50 28	4 51	491
Arras,	France	15	do.	M.T.	50 18	2 46	239
Amiens,	do.	15	do.	do.	49 54	1 18	102
Charleville,	do.	15	do.	do.	49 46	4 43	476
Nancy,	do.	15	do.	do.	48 42	6 11	725
Mirecourt,	do.	15	do.	do.	48 18	6 8	974
Epinal,	do.	15	do.	do.	48 10	6 26	890
Chalons-sur-Marne,	do.	15	do.	do.	48 57	4 21	294
Troyes,	do.	15	do.	do.	48 18	4 5	350
Paris,	do.	15	do.	do.	48 48	2 21	256
Versailles,	do.	15	do.	do.	48 48	2 7	421
Rouen,	do.	15	do.	do.	49 26	1 5	39
Fécamp,	do.	15	do.	do.	49 46	0 22	61
Caen,	do.	15	do.	do.	49 11	−0 21	69
St. Honorine-du-Fay,	do.	15	do.	do.	49 5	−0 30	388
Alençon,	do.	15	do.	do.	48 26	0 5	475
Le Mans,	do.	15	do.	do.	48 1	0 12	285
Rennes,	do.	15	do.	do.	48 7	−1 41	106
Lamballe,	do.	15	do.	do.	48 28	−2 31	252
Brest,	do.	15	do.	do.	48 23	−4 30	210
L'Orient,	do.	15	do.	do.	47 45	−3 23	86
Nantes,	do.	15	do.	do.	47 13	−1 33	136
Angers,	do.	15	do.	do.	47 28	−0 34	153
Poitiers,	do.	15	do.	do.	46 35	−0 40	384
Vendôme,	do.	15	do.	do.	47 47	1 4	291
Orléans,	do.	15	do.	do.	47 54	1 54	357
Bourges,	do.	15	do.	do.	47 5	2 24	510
Moulins,	do.	15	do.	do.	46 34	3 20	730
Clermont Ferrand,	do.	15	do.	do.	45 47	3 5	1296
Puy-de-Dôme,	do.	6	1878–83	do.	45 47	2 57	4813

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
32·2	31·6	34·9	41·7	50·2	58·6	62·6	61·5	55·8	47·5	39·0	33·6	45·8	...
33·0	32·4	35·7	42·8	50·3	57·2	61·5	61·1	55·8	47·3	39·1	33·4	45·8	...
31·5	30·8	33·8	40·6	48·7	56·7	59·7	59·4	53·2	44·8	36·7	31·5	44·0	...
33·1	31·5	34·9	41·7	50·0	57·9	61·6	61·0	55·2	47·3	39·7	33·6	45·6	...
32·1	30·7	34·5	42·1	49·8	58·4	62·1	61·2	55·3	47·2	38·7	32·1	45·4	...
34·1	32·3	34·8	42·2	49·4	57·0	60·7	60·3	55·5	47·4	39·3	34·1	45·6	+1·0
32·7	32·2	34·1	39·7	47·5	57·2	62·6	62·1	56·5	48·0	39·7	33·8	45·5	...
34·5	35·5	38·5	44·9	51·5	59·1	63·0	61·7	56·1	47·8	40·1	35·2	47·3	...
35·6	35·9	38·7	45·3	51·8	59·4	63·5	62·0	56·3	47·6	40·2	35·4	47·6	...
36·3	37·4	39·4	45·3	51·6	57·9	62·2	62·2	58·3	51·0	43·0	38·9	48·6	...
36·4	37·6	40·4	46·6	52·3	59·5	63·7	63·2	58·6	50·2	42·3	37·5	49·0	...
34·3	35·8	39·2	46·5	52·6	59·7	63·1	62·1	56·0	47·5	40·1	35·6	47·7	...
35·6	37·0	40·5	46·9	53·4	61·0	65·1	63·5	58·3	49·8	41·7	36·4	49·1	...
37·7	38·6	41·3	47·3	53·5	60·8	65·1	64·1	59·0	51·3	43·6	38·5	50·0	...
36·7	38·4	42·2	49·0	56·0	63·6	67·3	65·0	58·4	49·3	42·1	36·6	50·4	...
34·2	36·4	39·6	46·2	52·4	59·4	63·5	62·0	56·3	47·3	40·7	34·5	47·7	...
38·8	40·5	43·1	48·6	54·5	60·4	64·8	64·5	59·9	51·4	44·1	39·6	51·0	...
36·9	39·4	43·2	49·5	55·0	61·7	65·7	64·5	58·8	50·4	43·2	37·2	50·5	...
37·2	39·5	42·6	49·3	54·7	61·7	66·0	64·6	59·1	51·0	43·2	37·2	50·5	...
36·6	39·0	42·3	48·7	54·4	62·3	65·5	64·4	58·6	50·2	43·6	36·9	50·3	...
37·4	39·6	43·0	48·9	54·7	61·0	64·4	64·8	57·0	49·1	42·4	37·9	50·0	+1·0
37·6	40·3	43·9	50·6	55·2	62·3	67·0	66·4	59·6	49·8	43·7	36·9	51·2	−1·0
35·6	38·7	42·3	49·8	56·8	62·1	65·9	65·1	57·0	49·6	40·3	35·6	49·8	...
34·7	38·3	43·2	50·2	56·1	62·2	66·6	66·6	60·0	48·6	41·0	34·9	50·2	...
33·6	37·0	41·9	48·8	55·4	61·9	65·4	65·0	58·5	47·8	40·1	33·9	48·8	...
32·7	37·5	43·3	49·0	54·6	61·6	66·2	63·8	57·8	49·4	40·2	32·4	49·0	...
37·4	40·7	44·8	51·1	57·0	63·2	66·6	66·4	59·7	50·6	43·3	37·0	51·6	...
36·0	40·0	44·6	51·0	57·0	64·6	68·4	67·6	61·0	53·3	43·4	35·8	51·9	...
37·2	40·2	44·6	50·3	55·4	61·8	66·0	65·0	59·0	50·4	43·2	37·0	50·8	...
37·2	40·1	43·5	49·8	54·9	61·4	65·7	65·3	58·7	50·4	42·8	36·8	50·7	...
39·9	41·9	45·1	50·7	55·6	61·5	65·7	65·1	60·1	50·8	44·2	39·5	51·6	...
40·6	42·8	45·2	49·3	53·1	59·5	63·4	63·6	59·8	52·8	46·5	41·3	51·5	+1·5
39·9	43·7	46·2	51·1	55·4	60·8	63·9	63·3	59·0	51·3	45·7	40·3	51·7	...
39·6	42·3	44·2	48·9	53·6	59·2	63·6	63·0	58·6	51·4	45·0	39·9	50·7	...
37·9	40·3	44·4	49·5	54·5	61·5	65·7	64·8	60·3	50·5	43·7	38·1	50·9	...
37·4	41·5	45·5	50·0	54·9	61·5	65·1	64·9	59·7	51·8	44·4	37·2	51·2	...
40·5	44·4	47·3	52·2	56·0	60·8	66·2	65·5	60·4	52·6	47·1	41·0	52·7	...
38·8	42·8	45·1	49·6	54·0	58·8	61·9	62·6	58·6	51·3	45·7	40·6	50·5	...
43·5	45·1	46·6	51·1	55·4	59·5	64·1	64·6	61·0	54·3	48·2	43·6	53·1	...
42·1	44·5	46·6	51·6	55·7	59·8	64·8	64·2	61·3	55·5	48·4	42·8	53·1	...
39·9	43·7	47·5	52·2	57·0	61·2	65·8	65·4	60·4	53·2	46·0	40·3	52·7	...
39·0	42·8	46·9	51·8	57·6	61·5	66·2	65·8	61·0	52·5	45·5	39·9	52·5	...
38·6	42·1	45·9	50·9	56·7	62·2	66·2	65·3	60·5	52·0	43·7	39·0	51·9	...
37·6	40·5	44·4	50·7	55·8	61·5	66·9	65·8	60·3	52·7	43·5	37·2	51·3	...
38·3	41·4	45·7	51·1	57·9	64·4	68·9	66·7	61·2	53·1	45·7	38·7	52·8	...
37·8	41·4	46·0	51·3	57·4	63·9	68·2	67·1	60·8	50·9	43·7	37·4	52·2	...
36·1	40·5	45·5	50·0	56·8	63·1	67·6	66·6	60·6	51·8	42·8	36·1	51·5	...
37·4	41·7	44·8	51·1	56·1	62·2	66·6	66·4	59·7	51·6	43·3	37·0	51·5	...
28·0	30·5	32·0	33·8	39·9	46·0	50·8	51·3	45·6	39·4	32·7	28·4	38·2	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Limoges, . .	France	15	1870–84	M.T.	45	50	1	15	842
Le Roche-sur-Yon,	do.	15	do.	do.	46	40	−1	26	198
Rochebonne, .	do.	15	do.	do.	46	12	−2	20	0
La Grande-Sauve, .	do.	15	do.	do.	44	46	−0	19	331
Périgueux, . .	do.	15	do.	do.	45	11	0	43	291
Aurillac, . .	do.	15	do.	do.	44	56	2	26	2193
St. Martin de Hinx,	do.	15	do.	do.	43	35	−1	16	131
Lescar, . .	do.	15	do.	do.	43	20	−0	26	524
Pic-du-Midi, .	do.	6	1878–83	do.	42	57	0	8	9380
Montauban, . .	do.	15	1870–84	do.	44	1	1	21	318
Toulouse, . .	do.	15	do.	do.	43	37	1	26	636
Foix, . . .	do.	15	do.	do.	42	58	1	36	1421
Perpignan, . .	do.	15	do.	do.	42	42	2	53	104
Carcassonne, .	do.	15	do.	do.	43	13	2	19	384
Albi, . . .	do.	15	do.	do.	43	56	2	8	574
Rodez, . .	do.	15	do.	do.	44	21	2	34	2050
Besançon, . .	do.	15	do.	do.	47	14	6	2	845
Bourg, . .	do.	15	do.	do.	46	12	5	13	822
Lyons, . .	do.	15	do.	do.	45	46	4	49	637
Grenoble, . .	do.	15	do.	do.	45	12	5	43	714
Privas, . .	do.	15	do.	do.	44	44	4	36	997
Montpellier, . .	do.	15	do.	do.	43	37	3	53	121
Avignon, . .	do.	15	do.	do.	43	57	4	48	72
Marseilles, . .	do.	15	do.	do.	43	17	5	22	246
Barcelonette, .	do.	15	do.	do.	44	23	6	39	3714
Draguignan, .	do.	15	do.	do.	43	32	6	28	584
Nice, . . .	do.	15	do.	do.	43	42	7	17	89
Ajaccio, . .	do.	15	do.	do.	41	55	8	44	60
Faraman, . .	do.	15	do.	M.m.	43	18	4	42	20
La Planier, . .	do.	15	do.	do.	43	15	5	15	13
La Ciotat, . .	do.	15	do.	do.	43	12	5	36	7
San Sebastian, .	Spain & Portugal	15	do.	do.	43	19	−2	0	82
Bilbao, . .	do.	15	do.	do.	43	15	−2	56	52
Santander, . .	do.	15	do.	do.	43	29	−3	50	130
Oviedo, . .	do.	15	do.	do.	43	23	−5	55	738
Corunna, . .	do.	15	do.	do.	43	22	−8	25	82
Santiago, . .	do.	15	do.	do.	42	53	−8	34	863
Pontevedra, .	do.	15	do.	do.	42	26	−8	38	39
La Guardia, .	do.	15	do.	do.	41	25	−8	49	26
Montalegre, . .	do.	15	do.	do.	41	49	−7	45	3182
Oporto, . .	do.	15	do.	do.	41	9	−8	29	279
Salamancha, .	do.	15	do.	do.	40	58	−5	41	2671
Valladolid, . .	do.	15	do.	do.	41	39	−4	44	2346
Moncorvo, . .	do.	15	do.	do.	41	14	−4	58	1362
Huesca, . .	do.	15	do.	do.	42	7	−0	27	1598
Saragossa, . .	do.	15	do.	do.	41	38	−0	54	656
Barcelona, . .	do.	15	do.	do.	41	22	2	9	69
Valencia, . .	do.	15	do.	do.	39	28	−0	23	59
Alicante, . .	do.	15	do.	do.	38	21	−0	30	46
Cartagena, . .	do.	15	do.	do.	37	36	−0	47	20

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
37·4	42·6	45·0	50·7	56·8	62·1	66·6	66·4	59·4	52·4	43·5	37·8	50·9	...
39·9	43·7	46·4	51·1	56·7	60·8	65·1	64·5	59·5	53·2	45·3	39·6	52·2	...
47·1	48·9	50·2	53·4	57·9	62·4	67·5	68·2	64·0	59·0	53·0	46·9	56·5	...
39·4	43·7	47·5	53·1	57·9	63·1	68·2	68·0	62·6	55·0	47·1	39·9	53·8	...
40·3	44·2	47·5	52·5	58·4	63·9	68·0	67·3	61·0	53·8	45·3	39·8	53·5	...
36·3	40·0	42·5	47·0	55·1	58·4	63·2	62·9	56·4	49·0	42·5	37·0	49·2	−1·0
42·7	46·4	49·3	53·4	58·6	63·1	67·5	68·2	63·5	56·5	48·9	41·8	55·0	...
41·7	45·0	48·0	53·1	58·3	63·3	67·8	66·7	62·6	55·0	47·5	41·5	54·2	...
22·5	24·2	24·8	26·2	33·1	39·8	48·2	48·8	40·0	32·5	27·5	21·7	32·4	...
41·0	44·8	48·7	55·0	62·2	67·5	73·0	72·6	65·1	56·8	47·8	40·6	56·3	...
41·0	44·2	48·0	53·1	59·0	65·3	71·2	69·8	63·9	55·2	46·6	40·5	54·8	...
39·6	43·2	46·2	50·0	56·3	62·2	66·9	66·5	60·1	53·2	45·0	39·0	52·4	...
46·4	49·5	52·2	57·0	63·0	69·6	75·0	74·6	68·7	60·4	52·3	46·0	59·5	...
41·7	46·0	49·5	54·1	61·2	67·1	72·5	72·3	66·0	57·0	48·6	41·5	56·4	...
40·6	44·6	48·4	53·4	59·7	64·9	72·3	72·5	65·1	54·9	46·0	40·1	56·0	...
37·4	40·1	44·6	49·4	55·0	62·2	68·0	67·5	61·0	51·8	42·1	37·0	51·3	...
35·1	39·2	44·8	50·4	57·2	63·7	68·2	67·3	61·0	51·4	42·6	35·6	51·2	...
34·7	39·2	45·0	51·1	57·6	64·4	69·3	67·5	61·0	51·1	42·3	34·9	51·5	...
35·8	40·5	45·4	52·5	59·2	65·6	70·8	69·4	62·8	53·8	44·1	35·4	52·9	...
33·8	38·1	45·9	51·1	58·1	64·2	68·9	67·6	61·3	51·4	41·7	33·6	51·3	...
38·5	42·4	48·2	52·7	59·7	68·7	72·9	72·3	65·1	55·0	45·7	39·0	55·0	...
43·3	47·0	50·2	55·6	61·6	68·4	74·3	74·4	68·0	58·3	50·0	44·0	58·0	...
40·6	46·0	50·2	55·8	61·5	69·1	73·4	72·7	65·7	56·7	48·4	41·0	56·8	...
44·2	47·3	50·0	55·8	61·0	68·4	72·0	71·8	65·8	58·6	50·7	44·2	57·5	...
27·7	32·0	37·4	44·8	52·9	59·4	65·3	64·0	55·2	45·9	35·6	28·8	45·8	...
41·0	45·3	48·2	54·7	59·9	69·3	74·1	73·7	65·7	56·3	48·6	41·9	56·6	...
45·4	46·5	50·9	57·1	61·0	68·8	73·8	72·6	67·8	60·8	52·0	46·9	58·6	...
51·0	51·3	52·5	58·1	63·3	70·8	75·3	77·2	71·8	63·6	56·8	51·8	62·0	...
42·8	46·6	49·6	55·6	61·2	69·8	72·9	72·7	66·0	59·0	50·7	43·2	57·5	...
48·0	49·5	51·6	56·1	60·6	67·6	70·9	71·4	66·6	60·1	53·6	48·2	58·7	...
44·9	47·8	50·8	56·8	63·6	70·5	74·2	74·5	66·3	59·9	52·1	46·0	59·0	−1·5
46·8	49·1	51·0	54·7	59·5	62·8	66·9	68·7	65·1	61·2	52·7	48·2	57·2	...
47·7	51·0	52·9	56·8	61·1	65·7	70·0	71·6	67·4	60·8	52·9	47·0	58·7	...
48·4	50·7	51·1	54·8	58·0	61·7	65·6	67·4	64·4	60·5	54·2	49·3	57·2	...
45·1	48·5	49·2	52·2	55·7	60·2	64·2	65·4	62·7	56·9	51·7	45·1	54·7	...
47·8	49·8	49·9	53·3	57·0	61·2	64·0	66·1	62·5	57·3	52·9	47·2	55·7	...
46·2	48·1	49·7	52·5	57·3	61·8	65·5	67·1	63·1	56·5	51·4	45·7	55·3	...
47·2	50·4	52·7	56·0	60·9	64·6	68·8	69·4	66·0	58·7	53·4	47·4	57·9	...
47·0	50·1	52·7	55·9	60·4	64·0	67·9	68·6	65·5	59·7	53·7	46·6	57·7	...
38·0	39·7	43·4	46·5	51·8	57·2	63·6	64·6	58·6	49·4	44·6	38·5	49·7	...
49·2	51·2	54·5	57·0	62·1	65·4	69·4	69·1	66·7	60·2	54·2	48·5	58·9	...
39·6	43·5	47·2	52·0	57·7	64·9	71·8	72·2	62·8	55·4	46·7	39·2	54·4	...
38·0	42·3	45·6	50·3	57·9	63·7	70·4	71·3	63·5	54·0	45·2	37·1	53·3	...
42·0	45·5	50·8	56·0	61·8	68·3	74·8	75·8	68·2	58·5	49·6	41·4	57·7	...
40·5	44·2	49·1	53·3	60·3	67·1	74·6	74·8	66·2	57·3	47·3	38·5	56·1	...
42·2	47·6	52·5	56·5	64·0	70·6	77·8	77·0	69·7	59·6	49·3	41·6	59·1	...
47·7	50·4	52·9	57·0	64·2	69·4	75·7	77·0	71·4	63·7	55·0	47·9	61·0	...
50·8	53·5	55·2	59·3	64·6	70·5	76·3	78·1	72·4	66·1	57·9	50·4	62·9	...
51·5	53·6	55·7	60·9	65·8	71·8	77·5	78·9	74·4	66·5	58·6	51·1	63·9	...
52·9	55·4	57·4	63·6	66·0	74·5	79·9	80·3	75·0	67·5	60·6	54·0	65·6	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Murcia,	Spain & Portugal	15	1870–84	M.m.	37	59	−0	39	138
Albacete,	do.	15	do.	do.	39	0	−1	52	2251
Madrid,	do.	15	do.	do.	40	24	−3	42	2149
Coimbra,	do.	15	do.	do.	40	12	−8	30	463
Guarda,	do.	15	do.	do.	40	32	−7	14	3409
Lisbon,	do.	15	do.	do.	38	42	−9	8	335
Lagos,	do.	15	do.	do.	37	6	−8	38	43
Campo Maior,	do.	15	do.	do.	39	2	−6	59	945
Badajoz,	do.	15	do.	do.	38	54	−6	59	561
Evora,	do.	15	do.	do.	38	35	−7	52	1027
Ciudad Real,	do.	15	do.	do.	38	59	−3	57	2090
Jaén,	do.	15	do.	do.	37	47	−3	36	1926
Granada,	do.	15	do.	do.	37	11	−3	39	2198
Seville,	do.	15	do.	do.	37	23	−6	1	98
San Fernando,	do.	15	do.	do.	36	28	−6	13	92
Tarifa,	do.	15	do.	do.	36	0	−5	35	46
Gibraltar,	do.	15	do.	do.	36	8	−5	20	53
Malaga,	do.	15	do.	do.	36	43	−3	57	75
Palma,	do.	15	do.	do.	39	33	2	37	66
Basel,	Switzerland	15	do.	do.	47	33	7	35	912
Zurich,	do.	15	do.	do.	47	23	8	33	1575
Berne,	do.	15	do.	do.	46	57	7	26	1880
Geneva,	do.	15	do.	M.T.	46	12	6	8	1335
Lugano,	do.	15	do.	M.m.	46	0	8	57	902
Great St. Bernard,	do.	15	do.	M.T.	45	52	7	11	8130
Säntis,	do.	$4\frac{1}{3}$	1882–86	7 : 1, 9, 9	47	15	9	20	8094
Como,	Italy	15	1870–84	9 : 9, M.m.	45	51	9	7	367
Milan,	do.	15	do.	do.	45	28	9	11	482
Turin,	do.	15	do.	do.	45	3	7	41	906
Moncalieri,	do.	15	do.	do.	44	59	7	41	846
Mondovi,	do.	15	do.	do.	44	23	7	48	1824
Valdobbia,	do.	7	1878–84	do.	45	47	7	51	8360
Cremona,	do.	15	1870–84	do.	45	8	10	3	223
Udine,	do.	15	do.	do.	46	4	13	13	381
Belluno,	do.	15	do.	do.	46	8	12	14	1325
Venice,	do.	15	do.	do.	45	32	12	20	69
Padua,	do.	15	do.	do.	45	24	11	53	110
Vicenza,	do.	15	do.	do.	45	33	11	32	182
Mantua,	do.	15	do.	do.	45	10	10	47	131
Modena,	do.	15	do.	do.	44	39	10	56	211
Rovigo,	do.	15	do.	do.	45	3	11	47	30
San Maurizio,	do.	15	do.	do.	43	53	8	3	206
Genoa,	do.	15	do.	do.	44	24	8	55	177
Leghorn,	do.	15	do.	do.	43	33	10	18	79
Porto Ferraio,	do.	15	do.	do.	42	49	10	18	230
Florence,	do.	15	do.	do.	43	46	11	15	240
Forli,	do.	15	do.	do.	44	13	12	2	160
Pesaro,	do.	15	do.	do.	43	55	12	53	45
Ancona,	do.	15	do.	do.	43	37	13	31	99
Siena,	do.	15	do.	do.	43	19	11	19	1145

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
50·7	53·4	56·5	61·6	66·6	73·1	79·3	80·7	75·2	66·3	57·9	50·1	64·2	...
40·6	44·8	47·8	53·4	59·7	67·7	76·1	76·4	67·6	57·6	47·9	40·1	56·6	...
40·1	43·7	48·2	53·3	60·5	68·9	77·4	76·8	67·1	55·9	46·9	39·3	56·5	...
49·7	51·6	54·6	57·7	62·9	66·1	70·5	71·2	67·7	61·4	54·8	48·6	59·8	...
37·7	39·9	43·1	46·8	53·3	59·6	67·2	67·7	61·0	51·3	44·4	36·8	50·2	...
50·8	52·3	54·3	57·7	61·5	64·3	70·0	70·7	67·8	62·0	56·6	50·5	59·9	...
53·3	54·8	57·8	61·8	67·0	71·8	76·6	77·0	72·6	66·5	59·0	53·2	64·3	...
47·6	50·4	54·0	57·4	64·0	70·5	77·4	77·3	71·6	62·5	54·4	47·0	61·2	...
46·2	50·5	54·9	59·5	65·2	71·8	79·6	79·7	73·6	64·3	55·0	46·4	61·4	...
49·7	52·0	55·3	58·5	63·0	68·4	74·6	75·4	70·6	63·1	56·5	49·2	61·4	...
43·7	47·7	52·1	55·9	62·6	71·2	79·2	78·8	70·2	59·5	51·0	44·2	59·7	...
45·1	49·3	52·5	57·4	64·3	72·3	81·7	81·5	73·0	62·6	54·0	45·5	61·6	...
43·0	46·8	51·9	57·0	62·1	69·1	76·7	77·0	69·6	59·0	50·2	42·8	58·7	...
52·2	55·8	59·9	64·8	70·5	77·9	84·9	85·2	79·0	69·4	59·9	52·5	67·7	...
52·5	54·2	56·7	60·1	64·9	69·6	74·6	75·2	71·6	65·1	58·6	52·4	62·9	...
53·6	55·5	57·4	60·3	64·2	68·9	72·5	74·1	71·6	65·8	60·0	54·3	63·1	...
56·5	57·2	58·4	63·0	66·1	71·8	76·2	77·5	73·2	67·0	61·3	55·7	65·2	...
54·0	57·2	59·3	65·4	68·2	76·1	80·7	81·3	75·2	67·6	61·3	55·4	66·9	...
51·5	53·0	55·6	60·1	65·5	72·2	78·5	79·8	75·2	66·9	58·4	51·1	64·0	...
32·8	36·8	41·7	50·5	55·2	62·4	66·7	64·8	59·0	48·6	40·5	31·9	49·3	...
30·2	33·5	39·9	47·3	54·7	61·7	65·7	63·6	57·0	47·5	38·1	30·7	47·5	...
29·4	33·7	39·8	46·7	53·3	60·2	64·8	63·0	56·7	46·8	37·6	29·5	46·8	...
32·5	36·3	41·8	48·2	55·1	61·7	66·7	65·3	58·8	49·1	40·6	34·0	49·2	...
35·6	39·2	45·2	52·5	59·8	65·9	71·6	69·9	62·8	53·5	43·2	36·3	53·0	...
17·4	18·1	21·4	26·2	33·3	39·4	45·3	44·6	39·9	31·3	22·6	17·4	29·7	...
16·9	20·3	19·6	26·8	33·1	36·7	42·0	41·7	38·1	30·1	23·0	17·8	28·9	...
33·4	38·0	44·4	52·9	59·2	66·8	72·3	70·3	62·4	53·1	41·7	33·8	52·4	+2·0
34·7	40·8	47·3	55·6	62·8	70·7	77·0	74·7	66·7	56·0	43·5	35·6	55·4	...
33·6	39·2	46·8	54·1	61·5	68·2	73·8	72·1	65·1	54·9	43·2	35·1	54·0	...
33·6	38·5	46·0	54·0	61·4	68·4	74·5	72·5	64·8	54·2	42·4	34·5	53·7	...
34·3	38·1	43·5	50·2	57·9	65·3	71·2	69·6	62·4	52·5	41·4	35·4	51·8	...
19·4	22·1	24·4	29·1	36·1	40·8	47·8	48·2	40·8	32·7	24·3	19·6	32·1	...
34·0	40·4	47·5	55·0	64·4	71·2	76·5	74·5	67·8	55·4	42·3	34·7	55·3	+1·0
37·6	41·0	46·0	54·9	62·2	68·5	75·2	73·6	65·0	56·1	45·5	39·0	55·4	...
29·9	36·0	42·8	50·2	57·2	63·1	69·8	68·7	60·8	51·3	40·0	31·8	50·1	...
37·4	41·0	46·6	55·4	62·4	70·3	76·5	74·8	67·2	57·4	46·0	38·7	56·1	...
35·4	40·3	45·5	55·0	61·9	69·8	75·4	73·6	66·2	56·1	44·4	37·0	55·1	...
35·1	39·4	45·5	54·5	62·6	69·3	75·4	73·0	66·4	56·0	44·4	36·0	54·8	...
34·5	40·0	47·3	56·0	64·4	71·8	79·2	76·8	68·4	57·2	44·8	36·1	56·4	...
33·8	39·7	46·8	54·9	62·1	69·8	75·7	74·7	67·1	56·5	44·2	36·0	55·2	...
34·3	39·6	46·6	55·4	63·7	70·5	76·1	74·5	67·3	56·5	43·9	35·6	55·3	...
47·8	49·3	51·8	56·7	63·0	69·4	74·8	74·8	68·9	62·4	54·3	48·4	60·1	−1·0
45·5	48·6	51·6	56·7	63·5	69·6	75·4	75·4	69·8	63·0	53·4	47·5	60·0	...
45·3	48·0	51·1	57·4	63·9	70·3	75·9	76·1	70·3	62·4	53·6	46·8	60·1	...
48·3	48·3	51·8	56·5	62·0	70·7	74·9	74·6	69·8	63·0	55·6	48·7	60·4	...
40·6	44·6	48·6	56·7	62·6	70·2	76·3	75·6	68·5	59·2	48·9	42·4	57·9	...
35·6	41·2	46·8	55·6	63·1	71·1	77·7	75·6	68·0	57·7	45·7	36·7	56·2	...
39·4	43·2	48·1	55·8	63·0	70·4	76·3	75·8	69·0	59·8	48·6	41·1	57·5	+1·5
41·9	44·8	49·1	56·8	64·2	71·6	78·8	77·4	70·5	61·0	51·3	44·2	59·3	...
40·4	43·6	46·1	54·2	60·4	68·0	74·7	74·2	67·1	57·8	48·0	42·0	56·4	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	′	Longitude. °	′	Height, Feet.
Perugia,	Italy	15	1870–84	9 : 9, M.m.	43	7	12	23	1706
Orvieto,	do.	15	do.	do.	42	42	12	6	971
Chieta,	do.	15	do.	do.	42	22	14	11	1117
Aquila,	do.	15	do.	do.	42	21	13	21	2411
Rome,	do.	15	do.	do.	41	54	12	29	163
Montecasino,	do.	15	do.	do.	41	31	13	48	1730
Naples,	do.	15	do.	do.	40	52	14	15	489
Foggio,	do.	15	do.	do.	41	27	15	31	287
Potenza,	do.	15	do.	do.	40	39	15	48	2712
Lecce,	do.	15	do.	do.	40	22	18	12	236
Tropea,	do.	15	do.	do.	38	13	15	54	189
Cosenza,	do.	15	do.	do.	39	19	16	17	840
Reggio,	do.	15	do.	do.	38	8	15	39	59
Messina,	do.	15	do.	do.	38	12	15	39	176
Syracuse,	do.	15	do.	do.	37	3	15	15	71
Malta,	do.	15	do.	do.	35	53	14	30	70
Do.	do.	15	do.	M.m.	35	53	14	30	70
Girgenti,	do.	15	do.	9 : 9, M.m.	37	41	15	12	837
Palermo,	do.	15	do.	do.	38	7	13	21	237
Trapani,	do.	15	do.	do.	38	43	12	32	88
Cagliari,	do.	15	do.	do.	39	30	9	0	180
Sassari,	do.	15	do.	do.	40	40	8	35	718
Dolnja Tuzla,	Bosnia	15	do.	8 : 8	44	46	18	12	909
Sarajevo,	do.	15	do.	do.	43	56	18	26	1801
Mostar,	do.	15	do.	do.	42	20	17	49	205
Prisren,	Albania	2	1885–86	7 : 2, 9, 9	42	12	20	43	1434
Janina,	Turkey	6	1866–72	M.m.	39	47	20	57	1580
Constantinople,	do.	15	1870–84	do.	41	0	28	59	[0]
Sulina,	Bulgaria	15	do.	do.	45	9	29	40	6
Sofia,	do.	15	do.	M.T.	42	32	23	23	1761
Rustschuck,	do.	15	do.	do.	43	15	25	56	132
Bucharest,	Roumania	15	do.	do.	44	25	26	5	305
Corfu,	Greece	15	do.	7 : 2, 10	39	38	19	33	98
Athens,	do.	24	1859–82	M.T.	37	58	23	44	337
Candia,	do.	6	1879–84	8 : 9, M.m.	35	30	24	0	112
Hermannstadt,	Hungary	15	1870–84	7 : 2, 9	45	47	24	9	1381
Medgyes,	do.	15	do.	do.	46	7	24	22	1115
Bistritz,	do.	15	do.	do.	47	7	24	30	1204
Ungvár,	do.	15	do.	do.	48	36	22	18	463
Kesmarkt,	do.	15	do.	do.	49	8	20	26	2080
Neusohl,	do.	15	do.	do.	48	44	19	9	1217
Neutra,	do.	15	do.	do.	48	19	18	5	564
Presburg,	do.	15	do.	do.	48	9	17	6	505
Papa,	do.	15	do.	do.	47	20	17	28	518
Nagy-banga,	do.	15	do.	do.	47	38	23	35	745
Erlau,	do.	15	do.	do.	47	54	20	23	564
Budapesth,	do.	15	do.	do.	47	30	19	2	502
Debreczin,	do.	15	do.	do.	47	31	21	38	453
Orsova,	do.	15	do.	do.	44	42	22	25	174
Temesvar,	do.	15	do.	do.	45	46	21	14	338

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied
°	°	°	°	°	°	°	°	°	°	°	°	°	°
39·4	41·5	46·0	52·2	59·5	67·0	73·8	72·7	65·0	55·4	46·6	41·4	55·9	...
41·4	44·3	47·7	55·2	62·4	69·8	75·6	74·7	68·0	58·2	48·0	42·1	57·3	...
41·0	42·4	46·2	52·5	60·1	68·4	74·8	73·4	66·6	58·3	48·6	43·1	56·3	...
34·9	38·3	43·2	50·2	58·6	65·1	72·7	70·9	63·0	53·8	43·2	35·4	52·4	...
44·8	47·0	50·9	57·6	64·0	70·5	76·6	76·1	70·2	61·9	52·5	46·4	59·7	...
43·0	44·2	47·5	53·2	61·2	65·3	75·0	73·8	66·7	58·1	50·5	44·4	56·9	...
47·7	48·9	51·6	57·7	64·4	71·2	76·5	76·4	71·2	63·5	55·0	49·5	61·1	...
43·3	45·0	50·0	57·0	64·6	73·2	79·9	78·8	72·0	62·6	52·2	46·4	60·5	...
37·8	39·6	43·3	49·1	57·4	64·8	70·9	69·8	63·3	54·5	45·7	39·8	53·0	...
48·9	49·1	52·2	58·5	65·8	73·6	78·7	77·5	72·3	65·0	56·3	50·7	62·4	...
52·8	53·0	54·4	59·4	65·7	72·7	77·4	78·1	74·0	67·4	60·8	54·0	64·1	...
43·7	46·0	50·9	55·0	63·7	72·7	79·2	77·2	69·8	60·6	52·0	45·8	59·7	...
54·0	54·2	55·6	60·1	65·3	71·2	76·3	77·4	74·3	68·0	60·8	55·0	64·4	...
53·2	54·5	56·1	61·2	67·5	74·3	80·4	80·6	76·3	68·9	60·8	55·0	65·7	...
52·7	53·1	54·9	59·4	65·5	73·2	79·5	79·8	75·2	68·2	60·1	56·1	64·8	...
56·3	56·3	57·5	61·3	66·6	73·3	78·8	79·7	76·8	70·8	64·1	57·8	66·6	...
56·3	56·3	57·5	61·3	66·6	73·3	78·8	79·7	76·8	70·8	64·1	57·9	66·6	...
50·7	50·5	53·2	57·4	64·2	73·6	78·4	77·9	72·0	64·8	56·3	51·4	62·5	...
52·2	52·5	54·9	59·2	65·0	71·2	76·5	77·0	73·8	67·1	59·4	54·0	63·6	...
56·0	56·4	58·3	61·2	65·8	72·0	77·4	78·1	76·3	69·8	61·9	57·7	65·9	...
51·3	52·3	54·5	58·5	64·8	71·2	77·2	77·7	73·6	65·5	58·1	52·2	63·1	...
49·4	50·0	51·6	56·0	62·7	69·6	77·0	75·2	71·2	62·1	55·8	50·3	60·9	...
28·1	30·1	38·3	50·8	57·0	63·8	68·0	64·8	59·8	49·3	39·4	30·5	48·3	...
27·1	28·2	36·0	47·0	54·5	61·0	65·3	63·2	58·3	48·2	37·3	28·0	46·2	...
41·1	41·2	46·7	54·6	62·4	69·6	76·5	75·4	67·0	57·8	47·8	41·2	56·8	...
34·0	36·7	42·3	54·0	60·1	66·6	71·1	72·1	64·8	55·8	44·6	36·0	53·2	...
41·5	44·8	47·1	55·3	68·8	70·2	74·9	74·3	69·2	59·6	48·5	41·9	58·2	...
41·7	41·0	45·3	54·0	61·9	70·0	73·9	73·8	68·0	61·4	53·4	47·0	57·6	...
29·0	31·3	39·6	49·8	61·0	70·2	73·0	72·0	64·4	55·0	45·3	33·8	52·0	...
28·8	30·2	37·8	53·6	60·3	66·4	73·0	71·4	64·6	51·8	42·4	29·6	50·8	...
29·5	30·9	43·3	57·7	65·0	73·0	76·3	74·8	68·2	57·2	44·6	33·4	54·5	...
26·4	28·2	39·8	52·0	61·7	69·3	73·6	71·2	63·6	52·8	41·3	31·8	51·0	...
50·8	50·9	53·1	62·0	67·5	74·9	80·0	79·7	74·7	67·6	59·5	53·6	64·5	...
46·4	47·8	52·4	59·1	67·9	76·0	80·6	80·0	74·0	65·8	57·3	49·9	63·1	...
51·8	51·1	53·8	59·1	67·0	74·5	79·0	77·8	74·2	62·5	61·3	55·6	64·4	...
23·8	27·3	37·5	49·5	57·2	63·8	67·2	65·9	58·4	49·3	38·2	28·6	47·1	...
23·7	26·3	36·9	49·5	58·2	64·0	68·4	66·2	58·1	48·9	36·9	26·8	47·0	...
23·7	27·6	37·1	49·4	57·1	64·0	67·6	65·8	58·6	49·3	37·5	28·0	47·1	...
26·4	29·1	37·7	50·8	58·8	65·3	69·0	66·9	59·5	51·6	38·7	29·0	48·6	...
23·7	27·4	34·2	44·6	52·9	61·2	63·5	62·6	55·4	46·0	34·5	25·2	44·3	...
25·5	28·6	36·8	49·1	57·0	64·5	68·2	65·3	57·7	48·4	37·1	27·7	47·2	...
28·3	30·8	39·8	50·8	58·9	67·0	70·5	66·9	59·7	50·5	39·4	29·2	49·4	...
30·1	32·7	40·5	50·8	58·4	66·3	71·0	68·7	61·3	51·1	39·4	31·3	50·1	...
30·9	33·8	41·0	52·0	60·8	68·4	73·0	70·3	62·6	52·2	40·6	32·0	51·5	...
26·0	29·2	38·0	49·3	58·7	65·5	69·1	67·0	58·8	50·4	39·3	30·0	48·6	...
26·1	28·4	38·5	50·9	58·6	66·9	70·5	67·6	59·3	50·4	39·4	29·5	48·9	...
29·4	31·6	40·6	51·2	59·1	66·7	71·1	68·5	60·6	50·7	39·2	31·0	49·8	...
27·4	28·9	39·3	50·9	59·5	67·2	71·0	68·4	60·6	50·9	39·0	29·3	49·3	...
30·5	32·4	42·1	53·7	61·0	68·6	73·5	71·6	64·7	53·4	42·1	33·0	52·7	...
28·8	32·6	42·0	53·7	61·2	68·9	73·6	70·4	62·6	52·2	40·6	32·4	51·7	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Pancsova,	Hungary	15	1870–84	7 : 2, 9	44	52	20	39	259
Szegedin,	do.	15	do.	do.	46	15	20	9	289
Neusatz,	do.	15	do.	do.	45	15	19	50	276
Esseg,	do.	15	do.	do.	45	33	18	40	387
Brood,	do.	15	do.	do.	45	9	18	1	312
Kalocsa,	do.	15	do.	do.	46	32	18	58	338
Fünfkirchen,	do.	15	do.	do.	46	6	18	14	853
Gr. Kanizsa,	do.	15	do.	do.	46	27	17	0	545
Agram,	do.	15	do.	do.	45	49	15	59	535
Fiume,	do.	15	do.	do.	45	17	14	27	75
Zeng,	do.	15	do.	do.	45	0	14	54	118
Durazzo,	Austria	15	do.	do.	41	49	19	28	23
Punta d'Ostro,	do.	15	do.	do.	42	27	18	34	210
Ragusa,	do.	15	do.	do.	42	38	18	7	49
Knin,	do.	15	do.	do.	44	2	16	11	1161
Gospic,	do.	15	do.	do.	44	33	15	22	1842
Lissa,	do.	15	do.	do.	43	5	16	14	79
Lussinpiccolo,	do.	15	do.	do.	44	42	14	28	34
Lesina,	do.	15	do.	7 : 2, 10*	43	11	16	27	62
Pola,	do.	15	do.	7 : 2, 9	44	52	13	50	105
Trieste,	do.	15	do.	do.	45	39	13	46	85
Görz,	do.	15	do.	do.	45	57	13	37	308
Riva,	do.	15	do.	6 : 2, 10†	45	53	10	50	276
Laibach,	do.	15	do.	6 : 2, 10‡	46	3	14	30	943
Graz,	do.	15	do.	7 : 2, 9	47	4	15	28	1129
Obirgipfel,	do.	8	1879–86	do.	46	30	14	17	6706
Klagenfurt,	do.	15	1870–84	do.	46	37	14	18	1437
Salzburg,	do.	15	do.	do.	47	48	13	3	1430
Kremsmünster,	do.	15	do.	6 : 2, 10*	48	4	14	8	1260
Vienna,	do.	15	do.	7 : 2, 9	48	14	16	22	664
Eger,	do.	15	do.	do.	50	5	12	22	1493
Leipa,	do.	15	do.	do.	50	41	14	32	830
Prague,	do.	15	do.	do.	50	5	14	25	660
Brünn,	do.	15	do.	do.	49	11	16	36	692
Barzdorf,	do.	15	do.	6 : 2, 10*	50	25	17	6	846
Krakau,	do.	15	do.	6 : 2, 10	50	4	19	57	722
Lemberg,	do.	15	do.	7 : 2, 9	49	50	24	1	978
Tarnopol,	do.	15	do.	do.	49	36	25	36	1040
Sereth,	do.	15	do.	do.	47	57	26	4	1247
Passau,	Germany	15	do.	M.T.	48	34	13	28	1024
Regensburg,	do.	15	do.	do.	49	1	12	6	1178
Augsburg,	do.	15	do.	do.	48	22	10	54	1638
Munich,	do.	15	do.	do.	48	9	11	34	1734
Bayreuth,	do.	15	do.	do.	49	57	11	35	1132
Bamberg,	do.	15	do.	do.	49	54	10	54	796
Aschaffenburg,	do.	15	do.	do.	49	59	9	9	450
Friedrichshafen,	do.	15	do.	7 : 2, 9	47	39	9	25	1336
Stuttgart,	do.	15	do.	do.	48	47	9	11	881
Freiburg,	do.	15	do.	do.	48	0	7	51	955
Carlsruhe,	do.	15	do.	do.	49	0	8	25	404

* Changed to 7 : 2, 9 in 1886. † Changed to 7 : 2, 9 in 1874. ‡ Changed to 7 : 2, 9 in 1879.

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
30·4	33·0	43·1	55·9	61·6	69·2	74·0	71·5	64·0	53·6	41·5	32·4	52·6	...
29·0	32·3	41·6	53·0	60·8	68·2	72·1	69·7	62·2	52·4	40·7	31·7	51·1	...
31·2	35·5	44·2	54·6	60·7	68·1	72·5	70·2	63·1	53·9	42·9	34·7	52·6	...
28·8	32·7	43·0	52·5	60·1	69·8	72·3	70·3	63·3	53·1	41·0	30·7	51·5	...
29·8	33·4	43·3	54·0	60·6	68·5	71·8	70·0	62·6	53·0	42·0	34·0	52·0	...
28·9	33·3	39·9	53·4	61·2	69·3	73·2	71·4	62·8	52·7	41·0	32·0	51·6	...
29·2	33·1	41·5	52·0	58·9	66·1	70·7	69·1	61·9	51·4	40·2	32·4	51·4	...
29·4	31·9	40·6	50·7	58·3	66·7	70·9	68·2	59·7	50·3	39·6	30·4	49·7	...
31·3	34·8	43·4	52·7	59·8	66·6	71·7	69·3	62·0	51·6	41·7	32·9	51·5	...
42·8	44·1	48·1	55·7	61·9	68·7	74·5	72·9	66·9	58·7	49·8	44·2	57·3	...
41·7	44·5	48·6	55·7	62·9	71·5	76·6	74·8	68·2	58·7	49·4	43·9	58·0	...
46·4	48·4	52·2	58·6	65·4	71·8	77·0	76·1	70·2	63·3	55·0	49·8	61·2	...
48·7	49·2	52·5	58·5	65·4	72·7	77·8	77·0	71·4	64·0	55·7	50·2	61·9	...
47·7	48·6	51·3	57·9	63·9	71·4	77·2	76·6	72·0	63·0	55·4	49·8	61·2	...
39·2	42·3	45·0	54·0	60·3	69·7	74·5	72·7	65·8	56·7	45·8	39·7	55·5	...
27·6	31·0	38·4	48·0	55·5	63·5	69·0	66·8	58·4	49·3	38·2	30·8	48·0	...
49·6	50·0	52·1	58·2	63·8	71·4	76·6	75·8	71·1	64·3	56·8	51·5	61·8	...
45·3	46·0	48·8	56·4	63·3	71·0	76·6	75·0	69·6	60·7	52·8	47·5	59·4	...
47·3	48·2	51·2	57·6	64·8	71·7	77·3	76·0	70·6	62·9	55·1	49·6	61·1	...
41·5	42·9	46·7	54·3	61·5	69·4	75·0	73·4	66·6	58·6	49·4	43·7	56·9	...
40·5	42·3	47·0	55·6	62·5	70·3	76·3	74·5	67·5	58·3	48·4	42·2	57·1	...
38·0	40·5	46·2	55·1	61·4	68·7	74·2	72·5	64·6	55·6	45·3	38·9	55·3	...
38·2	41·7	47·6	54·8	61·6	68·5	73·7	72·7	65·8	56·7	45·8	39·0	55·5	...
27·8	31·9	39·5	49·0	56·4	63·4	68·0	65·6	58·1	49·6	38·3	30·6	48·2	...
29·0	31·7	39·6	49·8	59·4	64·0	67·8	65·8	58·9	49·9	37·8	29·8	48·6	...
19·2	22·7	23·2	29·0	34·6	42·2	48·4	47·1	42·7	34·2	26·8	21·2	32·6	...
21·6	27·1	36·1	47·7	56·0	62·9	66·9	64·4	56·5	47·0	34·5	23·9	45·4	...
28·3	30·9	38·9	47·5	54·1	61·6	65·2	63·3	57·0	48·1	37·6	28·4	46·8	...
27·6	30·3	38·0	46·2	53·6	60·6	65·3	63·1	56·2	46·6	36·0	28·5	46·0	...
29·6	32·4	40·3	49·1	56·6	64·2	68·5	66·0	59·1	50·0	38·7	31·1	48·8	...
27·6	29·7	35·1	43·8	51·2	59·4	63·4	61·3	54·7	45·0	35·8	27·9	44·3	...
28·2	29·9	36·0	45·3	53·1	60·6	64·5	62·7	56·2	46·4	37·0	28·6	45·7	...
30·2	33·4	38·3	47·0	55·0	63·1	67·1	65·5	58·7	48·4	38·3	31·1	48·0	...
28·6	30·9	38·4	49·4	56·2	63·9	68·4	66·0	58·6	48.7	38·0	29·7	48·0	...
29·9	31·0	36·9	45·5	53·7	62·3	66·0	64·1	57·7	48·0	38·8	30·1	47·0	...
26·0	27·6	35·7	46·4	53·2	62·3	65·5	63·0	56·8	46·8	36·6	26·9	45·7	...
24·4	25·6	31·7	44·7	53·9	62·4	65·4	62·8	55·1	45·5	36·1	26·9	44·6	−1·0
22·9	23·8	31·4	45·2	54·8	64·1	66·7	63·8	55·0	45·1	35·3	25·1	44·4	+1·0
23·9	26·2	34·2	46·6	56·7	64·4	67·5	64·8	57·7	47·3	35·0	25·3	45·8	...
27·2	30·8	36·6	46·7	54·1	60·7	64·8	62·8	56·7	46·9	36·0	28·8	46·0	...
28·1	30·1	37·8	47·5	55·6	61·9	65·8	64·0	56·8	46·7	36·3	28·6	46·6	...
27·9	30·7	36·7	44·8	51·9	59·2	64·0	62·2	55·8	45·5	35·2	27·8	45·1	...
27·6	30·5	36·7	45·2	51·9	59·3	63·7	61·9	55·0	45·3	35·4	27·5	45·0	...
27·7	30·5	36·1	44·6	51·9	59·6	63·1	61·1	54·4	45·1	35·9	28·6	44·9	...
28·9	31·3	37·7	46·0	53·6	61·3	64·8	63·5	56·5	46·8	37·4	29·5	46·4	...
30·2	34·2	39·5	48·0	54·9	61·6	65·1	63·5	57·3	47·5	39·2	31·8	47·7	...
30·4	33·4	39·4	47·5	53·6	61·5	65·5	64·2	57·4	48·0	38·8	31·1	47·6	...
32·5	36·3	42·1	49·1	55·8	63·3	66·9	65·5	59·0	48·2	40·5	32·4	49·2	...
32·6	37·3	42·3	49·8	55·9	62·7	67·6	65·6	59·0	48·6	41·4	32·4	49·6	...
33·4	36·3	41·9	49·3	55·9	63·1	67·0	64·5	58·3	48·4	40·8	33·0	49·3	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Heidelberg, . .	Germany	15	1870–84	7 : 2, 9	49 24	8 42	397
Trier, . . .	do.	15	do.	6 : 2, 10	49 45	6 38	492
Aachen, . .	do.	15	do.	do.	50 47	6 5	581
Cologne, . .	do.	15	do.	do.	50 56	6 57	197
Gütersloh, . .	do.	15	do.	do.	51 54	8 23	266
Göttingen, . .	do.	15	do.	do.	51 32	9 56	492
Kassel, . .	do.	15	do.	do.	51 19	9 30	670
Leipsig, . .	do.	15	do.	do.	51 20	12 23	387
Berlin, . .	do.	15	do.	do.	52 30	13 23	136
Ratibor, . .	do.	15	do.	do.	50 6	18 13	646
Breslau, . .	do.	15	do.	do.	51 7	17 2	483
Bromberg, . .	do.	15	do.	do.	53 8	18 0	162
Hannover, . .	do.	15	do.	do.	52 22	9 44	202
Emden, . .	do.	15	do.	do.	53 22	7 13	28
Helgoland, . .	do.	15	do.	do.	54 20	7 51	153
Ottendorf, . .	do.	15	do.	do.	53 48	8 54	24
Borkum, . .	do.	15	do.	8 : 8	53 35	6 40	13
Keitum, . .	do.	15	do.	do.	54 54	8 22	30
Hamburg, . .	do.	15	do.	various	53 33	9 58	64
Kiel, . . .	do.	15	do.	6 : 2, 10	54 20	10 8	15
Lübeck, . .	do.	15	do.	do.	53 51	10 41	66
Putbus, . .	do.	15	do.	do.	54 21	13 28	174
Stettin, . .	do.	15	do.	do.	53 25	14 34	128
Köslin, . .	do.	15	do.	7 : 2, 9	54 11	16 11	153
Posen, . .	do.	15	do.	6 : 2, 10	52 25	16 56	268
Klaussen, . .	do.	15	do.	do.	53 48	22 7	472
Dantzic, . .	do.	15	do.	do.	54 21	18 38	71
Königsberg, . .	do.	15	do.	7 : 2, 9	54 43	20 30	74
Memel, . .	do.	15	do.	6 : 2, 10	55 43	21 8	32
Torneå, . .	Finland	15	do.	9 : 2, 9	65 51	23 29	170
Sodankylå, . .	do.	15	do.	do.	67 24	26 16	594
Uleåborg, . .	do.	15	do.	do.	65 1	25 8	30
Kuopia, . .	do.	15	do.	do.	62 54	27 20	290
Kaskö, . .	do.	15	do.	do.	62 20	20 51	25
Tammerfors, .	do.	15	do.	do.	61 30	23 25	299
Viborg, . .	do.	15	do.	do.	60 43	28 26	0
Sordavala, . .	do.	15	do.	do.	61 42	30 22	118
Lampis, . .	do.	15	do.	do.	61 6	24 43	370
Åbo, . . .	do.	15	do.	do.	60 27	21 52	49
Kola, . . .	Russia	15	do.	7 : 1, 9	68 53	33 1	33
Mesen, . .	do.	15	do.	do.	65 30	44 16	52
Simnjaja-Solotiza,	do.	15	do.	do.	65 41	40 14	28
Archangel, . .	do.	15	do.	do.	64 33	40 32	16
Kem, . . .	do.	15	do.	do.	64 57	34 39	41
Powenez, . .	do.	15	do.	do.	62 51	34 49	160
Petrosawodsk, .	do.	15	do.	do.	61 47	34 23	233
Walaam, . .	do.	15	do.	do.	61 23	30 57	149
Ustssyssolsk, .	do.	51	1817–67	M.T.	61 40	50 51	328
Wytegra, . .	do.	15	1870–84	7 : 1, 9	61 0	36 27	196
Kargopol, . .	do.	15	do.	do.	61 30	38 57	440

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
34·4	37·0	42·3	49·8	55·7	62·7	66·7	64·3	59·0	49·2	41·4	34·0	49·7	...
34·7	37·5	42·2	49·0	55·6	62·6	66·6	64·4	58·3	49·2	41·8	35·0	49·8	...
36·3	39·4	43·0	49·3	55·0	61·7	65·7	64·4	58·6	50·2	42·6	36·7	50·2	...
35·9	38·5	42·7	49·3	55·0	62·3	65·8	64·6	59·1	50·5	42·7	36·8	50·2	...
34·3	35·8	39·9	47·0	53·8	61·3	64·5	62·8	57·0	48·5	40·7	34·5	48·3	...
31·6	33·6	38·3	45·8	52·9	60·4	64·0	62·2	55·9	47·1	39·0	32·2	47·0	...
31·6	34·3	38·8	46·4	53·1	59·9	64·0	62·0	56·1	47·3	39·0	32·5	47·1	...
30·6	32·4	37·5	45·3	53·2	61·2	65·0	63·2	56·4	46·5	37·8	31·2	46·7	...
32·8	33·6	39·0	47·1	54·7	62·9	66·7	64·9	58·7	48·9	39·9	32·8	48·5	...
29·2	30·0	37·0	46·3	54·3	62·7	66·2	63·9	57·4	47·8	38·1	29·9	46·9	...
29·4	30·0	36·5	45·5	53·9	62·1	65·8	63·9	57·6	47·6	38·3	30·1	46·7	...
27·9	28·8	34·6	43·7	52·0	62·2	65·1	62·8	55·8	45·7	37·0	29·2	45·3	...
34·2	35·8	39·6	46·5	53·7	61·3	65·4	63·5	57·5	48·5	40·4	34·5	48·5	...
32·9	34·2	38·5	45·1	51·3	58·8	63·3	62·3	56·5	47·8	39·8	34·2	47·1	...
34·8	34·4	39·3	43·0	49·2	56·5	61·2	61·7	57·9	50·6	42·5	37·0	47·4	...
33·4	34·0	37·8	44·6	51·4	59·4	63·0	61·9	56·4	47·8	39·4	33·4	46·9	...
35·4	35·0	38·7	44·8	50·4	58·3	63·0	62·0	57·7	49·6	41·4	36·1	47·6	...
33·1	32·4	35·2	42·8	48·7	58·1	62·0	60·8	56·1	47·8	38·7	34·7	45·9	...
33·1	34·1	38·4	45·2	52·1	59·8	63·4	62·4	56·6	47·7	39·2	33·2	47·1	...
33·6	34·1	37·1	43·6	50·7	59·1	62·8	61·7	56·3	47·8	39·8	34·4	46·9	...
32·1	32·6	36·9	43·6	51·2	59·9	63·5	61·5	55·7	46·9	38·4	32·8	46·3	...
30·8	30·9	34·8	42·1	50·2	59·1	62·9	61·5	56·3	46·6	37·8	31·9	45·4	...
31·0	32·0	35·4	44·8	53·2	61·6	65·7	63·7	56·8	47·3	38·6	31·7	46·9	...
29·2	29·9	34·9	42·4	50·1	59·0	62·9	61·2	55·2	46·0	37·4	29·5	44·8	...
29·3	30·4	35·4	45·1	53·1	62·5	66·0	63·7	57·2	46·8	37·9	30·2	47·3	...
23·4	24·1	30·5	41·9	52·2	61·6	64·5	62·1	54·9	43·2	34·2	24·7	43·1	...
27·6	28·7	34·9	42·3	50·3	60·0	63·8	62·2	56·2	45·6	36·8	29·6	44·9	...
25·5	26·3	32·3	41·3	49·8	59·7	63·4	61·5	55·3	44·3	35·5	27·1	43·5	...
26·6	26·2	31·4	40·3	48·6	59·4	63·3	61·8	55·4	44·5	36·0	27·7	43·4	...
13·0	10·9	17·4	29·6	41·5	54·0	60·6	56·2	47·2	37·0	21·0	12·1	33·4	...
6·0	4·8	13·7	27·3	40·7	55·0	60·8	54·3	43·5	28·7	14·6	4·6	29·5	...
15·0	13·8	20·8	31·2	43·0	56·5	61·8	57·4	48·2	36·6	23·7	15·3	35·3	...
14·2	13·5	20·6	31·1	43·5	57·8	61·5	57·0	47·8	36·7	25·8	14·3	35·3	...
21·9	20·0	25·2	30·7	40·3	52·7	58·4	56·1	50·4	40·8	31·8	22·1	37·5	...
19·4	18·7	25·7	34·9	45·9	58·0	62·8	59·0	50·6	39·4	30·0	20·0	38·7	...
17·8	17·9	24·6	34·7	47·0	54·4	61·3	55·9	51·1	40·8	30·6	19·4	38·0	...
14·7	14·8	22·4	32·8	45·0	58·5	63·5	59·4	50·6	39·1	28·5	16·9	37·2	...
20·0	18·4	25·4	35·8	46·7	59·2	61·5	57·3	50·0	38·7	29·3	20·5	38·6	...
21·9	20·8	25·9	36·0	46·2	59·0	63·3	59·0	51·5	40·8	31·4	21·9	39·8	...
13·0	10·8	19·5	28·3	37·6	49·3	55·8	53·4	43·0	31·5	17·9	12·6	31·1	...
4·2	4·5	17·4	25·4	36·3	49·4	56·6	52·8	42·0	32·0	17·7	6·0	28·7	...
11·0	10·2	19·5	28·2	36·2	47·3	54·1	52·2	44·8	35·7	23·6	12·8	31·3	...
7·7	8·3	17·8	27·8	40·5	54·7	60·8	56·9	46·2	34·9	20·5	9·2	32·1	...
13·3	12·6	19·2	28·9	38·8	52·3	58·5	55·7	46·8	34·9	22·7	13·1	33·1	...
10·8	10·5	19·6	31·6	43·4	58·8	62·7	58·6	47·4	36·5	25·1	12·9	34·8	...
14·6	13·0	21·4	32·0	43·1	57·6	61·8	58·6	49·5	37·5	26·0	16·4	36·0	...
18·8	16·0	22·6	33·6	44·1	57·0	61·8	60·4	51·8	40·6	30·5	21·2	38·2	...
4·6	9·0	20·0	32·5	43·9	56·0	61·6	56·9	46·0	33·0	19·5	7·1	32·5	...
12·0	13·3	22·4	34·8	47·0	59·3	62·8	59·2	49·5	37·1	24·8	15·8	36·5	...
8·2	10·4	18·5	32·4	45·7	58·5	63·1	56·5	47·5	35·6	22·0	12·4	34·2	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
St. Petersburg, .	Russia	15	1870–84	7 : 1, 9	59 56	30 16	19
Welikij-Usting, .	do.	13	1840–52	M.T.	60 46	46 18	262
L. Hogland, .	do.	15	1870–84	7 : 1, 9	60 6	26 59	37
Baltischport, .	do.	15	do.	do.	59 21	24 3	28
Pernau, . .	do.	15	do.	do.	58 23	24 30	32
Novgorod, . .	do.	15	do.	do.	58 31	31 18	62
Dorpat, . .	do.	15	do.	do.	58 23	26 43	223
Riga, . . .	do.	15	do.	do.	56 57	24 6	42
Windau, . .	do.	15	do.	do.	57 24	21 33	29
Libau, . .	do.	15	do.	do.	56 31	21 1	19
Weliki-Luki, .	do.	15	do.	do.	56 21	30 31	358
Wilna, . .	do.	15	do.	do.	54 41	25 18	387
Belostok, . .	do.	15	do.	do.	53 8	23 10	479
Warsaw, . .	do.	15	do.	bo.	52 13	21 2	392
Pinsk, . .	do.	15	do.	do.	52 7	26 6	459
Gorki, . .	do.	15	do.	do.	54 17	30 59	679
Tschernigov, .	do.	15	do.	do.	51 29	31 20	424
Kiev, . . .	do.	15	do.	do.	50 27	30 30	600
Gorodischtsche, .	do.	15	do.	do.	49 17	31 27	296
Ssoschanskoe, .	do.	15	do.	do.	49 34	28 55	920
Kischinew, . .	do.	15	do.	do.	46 59	28 51	286
Elizabethgrad, .	do.	15	do.	do.	48 31	32 17	417
Poltawa, . .	do.	15	do.	M.T.	49 33	34 38	460
Charkov, . .	do.	15	do.	7 : 1, 9	50 4	36 9	413
Kursk, . .	do.	28	1833-7,'40-59,'65-68	M.T.	51 45	36 0	689
Orel, . . .	do.	28	do.	do.	52 57	36 7	558
Woronesh, . .	do.	15	1870–84	7 : 1, 9	51 44	39 13	573
Semettschino, .	do.	15	do.	do.	53 30	42 37	378
Tambov, . .	do.	15	do.	do.	52 44	41 28	388
Gulynki, . .	do.	15	do.	do.	54 14	40 0	354
Moscow, . .	do.	15	do.	do.	55 50	37 33	509
Bielosersk, . .	do.	15	do.	do.	60 2	37 47	430
Wologda, . .	do.	15	do.	do.	59 14	39 53	374
Kostroma, . .	do.	26	1842–47, '49–69	do.	57 46	40 56	361
Nikolsk, . .	do.	15	1870–84	do.	59 32	45 27	390
Blagodat, . .	do.	15	do.	do.	58 17	59 47	1250
Perm, . .	do.	15	do.	do.	58 1	56 16	328
Slatoust, . .	do.	15	do.	do.	55 10	59 41	1343
Wjatka, . .	do.	15	do.	do.	58 36	49 41	580
Roschdestwenskoe,	do.	15	do.	do.	58 9	45 36	443
Nijni-Novgorod, .	do.	15	do.	do.	56 20	44 0	453
Kasan, . .	do.	15	do.	do.	55 47	49 8	249
Polibino, . .	do.	15	do.	do.	53 44	52 56	313
Simbirsk, . .	do.	15	do.	do.	54 19	48 24	476
Samara, . .	do.	15	do.	do.	54 19	48 0	197
Orenburg, . .	do.	15	do.	do.	51 46	55 6	297
Uralsk, . .	do.	15	do.	do.	51 43	50 55	358
Saratow, . .	do.	15	do.	do.	51 38	45 27	614
Urjupinskaja, .	do.	15	do.	do.	50 48	42 0	270
Kamyschin, .	do.	15	do.	do.	50 5	45 24	69

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
17·2	16·5	24·2	35·1	46·9	59·9	63·7	60·4	51·6	40·2	30·1	19·1	38·7	...
4·7	9·2	17·5	30·2	46·2	59·2	66·0	61·2	48·9	34·5	21·8	10·9	34·4	...
22·5	19·9	25·3	33·3	42·5	55·7	62·1	60·9	53·8	43·8	34·6	25·9	40·0	...
24·2	22·6	27·0	36·4	45·7	56·8	62·2	59·9	53·6	43·1	34·0	25·3	40·9	...
22·5	21·8	26·3	36·0	47·7	59·8	64·0	60·9	54·6	42·1	33·3	23·7	41·1	...
17·0	18·3	24·7	37·7	50·2	62·0	64·8	61·2	51·8	39·8	28·8	19·5	39·6	...
20·1	19·3	26·1	37·2	49·1	61·5	64·0	59·9	52·0	40·6	29·8	21·4	40·1	...
23·6	23·6	29·4	40·0	50·5	62·4	65·7	61·9	55·2	42·6	34·3	25·9	42·9	...
26·3	25·3	29·7	37·6	46·4	57·6	62·3	60·6	54·8	44·0	35·5	27·4	42·3	...
27·0	26·3	31·5	39·3	47·2	58·6	63·0	61·9	55·8	44·8	35·8	28·3	43·6	...
18·0	19·4	26·0	39·8	52·0	62·4	65·6	61·4	52·0	40·0	29·5	20·9	40·6	...
23·0	23·6	30·6	43·4	53·4	63·5	65.9	62·2	54·6	43·2	33·8	24·8	43·5	...
24·0	25·2	31·2	44·2	54·7	63·7	66·2	63·5	56·5	44·6	35·8	25·8	44·6	...
26·0	26·9	33·9	44·5	54·1	63·7	66·7	63·6	56·3	45·0	35·9	27·1	45·3	...
23·3	23·9	33·0	46·0	55·4	64·8	66·8	64·0	55·0	43·4	34·6	24·0	44·5	...
17·0	16·1	26·1	39·3	52·7	62·8	64·8	61·3	52·0	40·1	30·4	20·9	40·3	...
21·0	21·6	29·5	44·7	57·5	66·4	69·4	66·7	56·6	43·9	34·0	23·4	44·6	...
20·6	21·2	29·8	45·0	57·6	66·0	68·5	65·6	56·5	44·2	35·7	22·6	44·5	...
21·8	24·4	32·6	49·1	59·7	67·5	69·8	68·5	59·8	48·6	38·5	26·2	47·2	...
20·8	21·0	30·2	44·2	55·8	64·2	67·0	64·8	55·0	43·7	34·2	23·5	43·7	...
25·8	26·6	36·5	49·5	60·0	68·4	72·5	70·0	61·0	49·3	39·4	31·0	49·2	...
20·3	21·6	33·0	47·6	59·3	67·6	71·2	68·6	58·1	46·8	36·0	24·3	46·2	...
17·6	17·1	29·7	45·3	58·4	66·2	70·2	67·1	57·4	43·6	34·9	23·3	44·2	...
18·5	20·0	30·7	45·6	58·3	66·8	70·3	66·9	55·2	45·0	35·1	24·0	44·7	...
14·0	16·3	25·3	40·4	55·5	63·4	66·7	65·0	54·9	41·6	29·7	20·4	41·2	...
13·4	15·1	23·2	40·9	55·6	63·2	66·8	63·8	53·3	40·2	30·2	18·7	40·4	...
14·5	14·8	25·0	42·5	58·5	66·4	69·0	66·0	55·2	42·4	32·2	20·6	42·3	...
9·7	11·5	22·0	38·2	55·5	64·4	68·5	64·1	52·3	40·0	28·4	16·6	39·3	...
10·5	13·2	23·4	39·8	57·1	65·5	69·8	65·0	53·4	39·0	29·8	16·9	40·3	...
12·3	11·6	22·3	38·0	54·3	63·8	66·6	63·3	51·8	39·5	28·8	16·9	39·1	...
13·1	13·5	23·7	37·2	52·9	63·2	66·2	61·5	50·8	39·6	29·5	17·2	39·0	...
12·6	12·8	21·6	33·2	46·0	60·0	64·1	59·5	49·8	37·0	24·0	15·6	36·3	...
10·7	14·6	21·9	35·2	49·6	62·2	66·6	61·7	51·3	37·3	27·3	16·8	38·0	...
10·9	11·7	20·8	35·3	51·3	61·8	66·2	62·0	51·1	38·9	25·0	15·4	37·5	...
6·2	11·0	23·2	34·7	50·0	60·7	64·5	58·6	45·2	36·0	24·2	10·3	35·4	...
2·6	5·7	19·2	32·0	46·8	56·7	62·0	56·9	44·7	32·0	10·6	5·3	31·7	...
2·3	3·8	20·1	32·9	49·2	60·0	65·3	59·1	46·2	35·5	22·3	9·7	33·9	...
2·3	4·3	19·3	34·2	51·0	58·0	61·5	57·8	46·0	33·4	21·5	6·5	33·0	...
5·3	6·9	20·1	33·1	48·6	60·4	65·0	59·3	46·4	36·0	22·2	9·6	34·4	...
7·8	11·0	22·3	38·1	51·3	60·4	65·0	59·0	47·7	38·4	22·8	12·0	36·3	.
11·6	11·4	21·2	37·4	55·0	63·2	68·5	63·6	50·8	38·8	27·5	14·8	38·7	...
7·0	8·8	20·0	37·2	54·2	63·9	67·8	62·8	50·5	38·3	25·9	13·0	37·4	...
6·0	5·5	20·2	37·6	55·7	64·0	66·3	63·5	49·8	37·4	26·3	14·0	37·2	...
9·2	8·6	20·6	38·8	55·7	64·6	68·6	64·2	50·8	38·8	25·4	14·6	38·3	...
6·9	7·7	19·1	38·7	56·6	64·8	68·2	64·4	52·4	39·4	26·9	14·4	38·3	...
4·1	3·3	17·6	42·0	58·6	67·4	70·8	67·1	54·2	39·4	26·2	14·0	38·7	...
6·4	4·8	16·0	37·4	58·8	66·9	69·6	68·0	52·0	39·6	25·6	13·6	38·2	...
11·3	11·5	22·5	41·4	59·9	68·9	71·4	68·9	57·2	42·1	31·5	18·0	42·1	...
12·6	14·3	25·5	44·2	59·0	67·3	71·6	68·0	55·4	44·4	32·5	19·4	42·8	...
14·5	13·6	25·0	42·8	62·4	69·7	76·1	72·2	58·3	45·8	32·6	19·0	44·3	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude,	Longitude.	Height, Feet.
					° ′	° ′	
Malyj-Usen, . .	Russia	15	1870–84	7 : 1, 9	50 31	47 37	95
Lugan, . .	do.	15	do.	do.	48 35	39 20	170
Taganrog, . .	do.	15	do.	do.	47 12	38 59	114
Nikolaev, . .	do.	15	do.	do.	46 58	31 58	62
Odessa, . .	do.	15	do.	do.	46 29	30 44	214
L. Tarchankut, .	do.	15	do.	do.	45 21	32 31	12
Sebastopol, . .	do.	15	do.	do.	44 37	33 31	199
Simferopol, . .	do.	37	1821–53, '66–72	M.T.	44 56	34 5	853
Theodossija, . .	do.	15	1870–84	7 : 1, 9	45 2	35 23	[0]
Kertsch, . .	do.	15	do.	do.	45 21	36 29	18
Prischib, . .	do.	15	do.	do.	45 3	38 55	121
Noworossijsk, .	do.	15	do.	do.	44 43	37 46	12
Suchum, . .	do.	15	do.	do.	42 58	40 55	28
Poti, . . .	do.	15	do.	do.	41 36	42 46	24
Batum, . .	do.	15	do.	do.	41 40	41 38	10
Eriwan, . .	do.	15	do.	do.	40 10	44 30	3230
Alexandropol, .	do.	20	1849, '51–70	do.	40 48	43 49	4823
Kutais, . .	do.	15	1870–84	do.	42 16	42 42	550
Tiflis, . .	do.	15	do.	do.	41 43	44 47	1343
Elissawetpol, .	do.	15	do.	do.	40 41	46 21	1456
Wladikawkas, .	do.	15	do.	do.	43 2	44 41	2244
Pjatigorsk, . .	do.	15	do.	do.	44 3	43 5	1667
Stawropol, . .	do.	15	do.	do.	45 3	41 59	1919
Astrachan, . .	do.	15	do.	do.	46 21	48 2	−68
Gurjew, . .	do.	15	do.	do.	47 7	51 55	−58
Boasta, . .	do.	15	do.	do.	45 47	47 31	−85
Petrovsk, . .	do.	15	do.	do.	42 59	47 31	−33
Port Alexandrowský,	do.	15	do.	do.	44 31	50 15	−83
Krassnowodsk, .	do.	15	do.	oo.	40 0	52 59	−70
Baku, . . .	do.	15	do.	do.	40 22	49 50	7
Lenkoran, . .	do.	15	do.	do.	38 46	48 51	−70
Aschur-Ade, .	do.	15	do,	do.	36 54	53 35	−79
Merv, . . .	do.	1	1885–86	do.	37 36	61 47	936
Samarcand, . .	do.	15	1870–84	do.	39 39	66 57	2379
Taschkent, . .	do.	15	do.	do.	41 19	69 16	1516
Margelan, . .	do.	15	do.	do.	40 28	71 43	2000
Aulie-ata, . .	do.	6	1870–75	do.	42 53	71 23	1620
Karakol, . .	do.	4⅓	1881–83, '85–86	do.	42 30	77 26	5400
Wernyj, . .	do.	15	1870–84	do.	43 16	76 53	2440
Kuldscha, . .	do.	4	1853–54, '56–60	do.	43 56	80 56	1706
Petro-Alexandrovšk,	do.	15	1870–84	do.	41 28	61 5	326
Nukuss, . .	do.	15	do.	do.	42 27	59 37	216
Perowsk, . .	do.	15	do.	do.	44 51	...	394
Kasalinsk (Fort),	do.	15	do.	do.	45 46	62 7	149
Irgis, . . .	do.	15	do.	do.	48 37	61 16	367
Staro Ssidorowa, .	do.	15	do.	do.	55 26	65 10	322
Akmolinsk, . .	do.	15	do.	do.	51 12	71 23	1004
Semipalatinsk, .	do.	15	do.	do.	50 24	80 13	594
Ulala, . . .	do.	15	do.	do.	51 59	86 2	1300
Barnaul, . .	do	15	do.	do.	53 20	83 47	459

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
10·7	10·9	21·6	40·2	61·8	69·0	75·2	70·7	56·2	43·3	30·6	16·5	42·2	...
18·7	18·2	30·9	47·6	61·2	68·9	72·1	70·0	58·8	46·7	37·5	25·8	46·4	...
20·6	21·4	31·9	48·6	62·2	70·3	73·0	72·4	61·3	49·2	36·9	28·3	48·0	...
24·9	25·4	35·3	49·0	61·7	70·2	74·2	71·9	62·4	50·4	41·1	30·0	49·7	...
26·4	26·6	35·5	47·9	60·4	69·4	73·3	71·2	62·3	51·6	42·4	32·4	50·0	...
33·9	33·4	38·7	47·9	58·9	68·9	74·2	73·0	65·3	55·1	47·7	40·0	53·1	...
35·8	34·9	41·5	50·5	60·8	69·2	74·0	72·7	65·3	56·3	49·8	42·2	54·4	...
31·0	32·0	38·9	48·0	58·3	65·2	69·3	69·1	61·0	51·6	43·4	34·2	50·2	...
31·7	31·5	40·0	50·4	61·5	71·1	76·0	74·3	66·2	56·5	48·0	37·8	53·7	...
30·0	30·6	38·0	49·2	61·2	70·3	75·0	73·8	65·6	55·4	47·3	37·0	52·8	...
27·2	29·0	39·4	50·6	62·4	69·6	74·8	73·0	63·1	53·1	44·4	33·6	51·7	...
35·3	35·5	42·4	52·0	62·4	69·1	75·5	745	65·0	56·5	48·2	41·7	54·8	...
43·7	43·0	46·2	55·8	64·3	68·5	74·4	75·2	69·0	63·0	57·2	48·7	59·1	...
42·3	42·6	47·7	54·3	62·7	69·3	74·1	75·1	69·1	62·4	55·2	47·9	58·6	...
42·8	42·8	47·0	54·0	63·1	70·4	75·0	76·0	69·8	62·6	56·3	50·0	59·2	...
16·6	23·0	36·4	51·6	65·4	72·0	77·7	79·0	68·5	57·2	46·8	29·6	52·0	...
12·4	15·3	28·6	41·1	53·1	59·5	65·2	65·7	57·4	46·7	35·1	21·2	41·8	...
38·4	41·5	47·8	56·7	65·6	69·7	74·0	75·3	67·3	61·2	53·4	45·5	58·0	...
34·3	35·6	44·1	52·0	65·2	71·4	76·9	77·3	67·4	57·7	47·7	39·2	55·7	...
34·5	35·3	44·4	54·9	64·6	72·0	78·0	77·2	67·5	58·2	47·5	39·2	56·1	...
24·4	25·3	34·7	47·5	58·5	64·0	68·3	67·9	59·5	49·0	40·8	31·5	47·6	...
24·7	24·1	35·6	48·1	59·7	66·9	71·6	70·8	60·8	51·5	40·7	31·3	48·8	...
25·2	26·5	34·2	46·1	57·4	64·2	68·8	68·2	58·2	48·4	41·0	32·2	47·5	...
20·6	21·2	32·7	49·6	65·1	74·3	78·1	75·0	63·5	50·6	38·8	28·2	49·8	...
15·5	16·9	29·3	50·0	65·2	73·4	77·3	75·2	62·6	47·0	35·4	20·8	47·5	...
22·0	22·5	32·6	49·0	63·2	71·8	76·8	74·8	63·3	52·0	41·9	27·8	49·8	...
30·8	32·6	39·6	50·8	62·6	72·0	77·0	76·5	68·6	58·5	47·6	36·0	54·4	...
26·0	26·5	37·8	51·2	65·0	74·1	79·3	77·4	66·5	53·7	41·5	31·6	52·6	...
36·5	37·7	47·4	58·7	69·7	78·0	83·3	84·0	74·4	63·0	52·6	43·6	60·7	...
39·2	39·0	44·4	53·7	66·4	74·6	79·8	80·2	72·4	62·8	54·3	45·1	59·3	...
39·0	40·4	46·7	56·4	67·6	75·9	79·6	80·6	73·0	63·3	55·2	45·8	60·3	...
45·2	45·8	51·6	62·0	70·0	77·6	81·7	83·4	78·2	69·0	60·3	51·4	63·0	...
33·3	24·1	50·0	61·2	71·8	(81·5)	88·0	85·6	72·7	60·1	50·0	37·0	59·6	...
30·8	34·5	48·2	58·0	71·0	78·0	81·9	77·2	66·0	56·3	46·7	40·2	57·4	...
29·6	32·7	48·0	59·5	72·3	78·3	81·6	77·0	63·6	52·9	43·6	37·4	56·4	...
29·0	31·2	46·4	60·4	71·7	80·0	83·8	81·0	68·0	55·2	43·3	35·1	56·9	...
24·8	26·7	39·7	55·3	66·5	70·4	73·4	70·3	63·0	49·9	39·2	35·2	51·5	...
22·8	20·2	35·2	46·2	53·4	60·9	62·4	62·1	54·1	42·4	31·8	25·7	43·1	...
13·4	16·8	30·8	52·2	65·5	72·7	75·6	72·7	62·0	44·4	32·9	19·6	46·6	...
16·3	20·6	36·4	54·5	66·2	73·6	76·7	73·1	64·6	48·1	32·9	25·7	48·0	...
23·2	26·4	44·5	59·8	73·6	79·5	83·0	80·4	67·0	51·6	38·2	29·6	54·8	...
22·0	24·2	41·7	51·7	71·1	76·8	80·0	76·8	65·7	47·8	37·1	27·8	52·4	...
14·7	16·3	34·6	51·7	70·6	75·3	77·8	74·6	62·4	45·0	32·2	21·5	48·1	...
12·0	12·8	30·6	49·5	66·7	74·8	77·9	74·9	62·7	44·6	30·9	19·5	46·4	...
2·3	3·1	20·7	44·2	64·5	73·0	76·8	73·4	59·3	41·7	26·0	12·2	41·4	...
−3·3	−0·6	16·7	40·5	56·5	64·8	68·0	64·3	49·3	32·7	20·0	6·4	33·8	...
−1·5	2·3	14·5	35·0	56·3	65·0	69·8	65·0	51·6	35·5	17·3	5·2	34·6	...
−0·4	2·8	18·1	37·3	58·8	68·5	73·8	68·4	55·4	38·1	19·0	4·8	37·1	...
1·0	1·6	15·3	34·5	53·3	63·5	68·6	62·3	50·6	36·0	18·6	4·3	34·2	...
−0·9	1·4	16·2	33·4	53·1	63·1	68·6	62·5	51·2	35·5	16·7	2·6	33·7	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height. Feet.
					° ′	° ′	
Tomsk, . .	Russia	15	1870–84	7 : 1, 9	56 30	84 58	254
Narym, . .	do.	15	do.	do.	59 21	80 16	197
Omsk, . . .	do.	15	do.	do.	54 58	73 20	261
Catharinenburg, .	do.	15	do.	do.	56 49	60 38	894
Tobolsk, . .	do.	15	do.	M.T.	58 12	68 16	355
Dalmatow, . .	do.	15	do.	do.	56 13	63 0	330
Irbit, . .	do.	15	do.	7 : 1, 9	57 41	63 2	223
Bogoslowsk, .	do.	15	do.	do.	59 45	60 1	636
Beresow, . .	do.	15	do.	do.	63 56	65 4	120
Obdorsk, . .	do.	15	do.	do.	66 31	66 35	80
Gydaviken, . .	do.	1	1880–81	4, 8, N. : etc.	72 20	76 42	[0]
Turuchansk, .	do.	10½	1877–87	7 : 1, 9	65 55	87 38	60
Enisseisk, . .	do.	15	1870–84	do.	58 27	92 6	275
Krassnojarsk, .	do.	15	do.	do.	56 1	92 49	498
Irkutsk, . .	do.	15	do.	7 : 1, 9	52 16	104 16	1536
Udinsk, . .	do.	4	?	do.	51 49	107 44	2100
Selenjinsk, . .	do.	15	1870–84	do.	51 6	106 53	1870
Kjachta, . .	do.	15	do.	do.	50 20	106 35	2356
Urga, . . .	do.	15	do.	do.	47 55	106 50	4300
Wercholensk, .	do.	15	do.	do.	54 8	105 30	1550
Banschtschikowa, .	do.	15	do.	do.	58 3	108 35	984
Olekminsk, . .	do.	15	do.	do.	60 22	120 26	400
Yakutsk, . .	do.	35	1829–54, '62–73	M.T.	62 2	129 45	334
Marchinskoe, .	do.	15	1870–84	7 : 1, 9	62 10	129 43	535
Werkojansk, .	do.	5	1869–72, '83–87	do.	67 34	133 51	460
Sagastyr, . .	do.	2	1882–84	do.	73 23	126 35	16
Tolstoj Noss, .	do.	1	1866–67	M.T.	70 10	82 52	32
Kasatsche, . .	do.	¾	1885–86	do.	70 45	135 58	32
Ljachow Island, .	do.	½	1886	do.	73 30	142 0	32
Kotelnyj and Fadeew Island, .	do.	½	1886	do.	75 0	138 148	32
Ssredne-Kolymsk,	do.	4½	1862, '75–7, '86–7	7 : 1, 9	67 10	157 10	98
N. Kolymsk, .	do.	2	1820–23	M.T.	68 32	160 56	32
Port Providence, .	do.	⅚	1848–49	hourly	64 30	−173 6	0
Anadyr River, .	do.	¾	1866–67	6, N. : 8	64 55	177 19	20
Kljutschewskoe, .	do.	2	1885–87	7 : 1, 9	56 4	160 31	[0]
Petropaulovsk, .	do.	7	1828, '46, '48–53	M.T.	53 0	158 39	49
Bering Island, .	do.	4	1882–86	do.	55 12	165 55	20
P. Okhotsk, .	do.	9½	1843–52	do.	59 20	142 40	12
P. Ayan, . .	do.	5½	1843–45, '47–50	7 : 2, 9	56 27	138 11	45
Udskoj, . .	do.	1	1844–45	thrice daily	54 29	134 37	262
P. Karoosakowsky,	do.	2½	1853–54, '68–69	7 : 1, 9	46 39	142 48	66
Nertschinsk, .	do.	15	1870–84	do.	51 19	119 37	2165
Blajoweschtschensk,	do.	15	do.	do.	50 15	127 38	361
Chabarowka, .	do.	15	do.	do.	48 26	135 7	60
Nikolaewsk, .	do.	15	do.	do.	53 8	140 45	60
Due, . . .	do.	15	1864–66, '68, 74–75	M.T.	50 50	142 7	330
Kussunai, . .	do.	2½	1860–61, '67–69	6 : 2, 10	47 49	142 20	10
Olga, . . .	do.	10	1875–85	7 : 1, 9	43 44	135 20	149
Wladiwostock, .	do.	10	do.	do.	43 7	131 54	57

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
−3·5	−0·5	16·1	29·9	47·7	59·8	67·5	60·4	48·6	33·1	13·4	−1·1	31·0	...
−7·4	−2·0	12·6	30·3	45·5	59·5	67·5	59·1	47·4	30·0	9·5	−2·2	29·2	...
−3·1	0·0	15·8	32·0	50·7	61·6	68·8	62·4	50·9	33·6	15·6	−0·7	32·8	...
2·4	5·7	19·7	33·6	50·2	59·1	63·8	59·4	46·8	34·5	21·4	6·6	33·5	...
−1·9	3·5	18·3	32·8	50·7	61·3	67·8	63·5	48·5	34·0	17·8	3·0	33·3	...
2·6	5·9	18·6	35·1	54·4	62·7	67·2	63·3	49·6	36·3	22·9	8·2	35·6	...
2·4	4·6	20·3	32·0	52·0	59·9	64·0	60·2	48·1	35·0	20·4	5·8	33·7	...
−2·4	3·0	17·8	30·6	46·2	57·7	62·8	57·5	44·7	32·1	15·6	−0·3	30·3	...
−10·8	−4·6	10·2	22·8	35·6	50·3	59·6	55·6	39·7	25·9	8·6	−7·0	23·9	...
−14·8	−10·8	4·6	15·2	26·1	42·6	56·0	52·0	35·6	22·3	4·8	−10·6	18·5	...
−23·1	−29·0	−4·7	0·3	16·5	29·3	34·3	(33·0)	(27·0)	11·1	0·3	−8·3	7·2	...
−19·3	−9·7	5·6	12·8	28·3	45·8	60·4	53·2	38·6	18·1	−2·8	−12·6	16·6	...
−10·3	0.0	17·1	29·5	45·5	60·8	68·0	60·8	46·5	30·2	8·4	−7·6	29·0	...
−4·7	2·0	17·6	34·6	50·0	62·5	68·6	61·8	48·3	35·0	13·0	−0·5	32·5	...
−6·8	−1·5	17·0	34·3	48·2	60·8	65·9	60·5	47·6	32·0	12·1	−3·5	30·3	...
−7·2	−2·4	19·0	35·1	48·4	61·9	68·6	64·6	49·6	31·5	11·1	−2·0	30·0	...
−14·2	−7·8	13·9	37·8	50·8	64·0	71·7	66·8	52·2	34·5	10·9	−8·1	31·0	...
−12·0	−5·8	15·8	35·0	48·7	63·0	66·9	61·6	48·6	31·2	9·8	−6·6	29·7	...
−17·2	−5·1	14·4	34·5	46·8	59·9	64·5	60·1	49·1	28·9	8·4	−8·0	29·0	...
−19·3	−11·0	11·3	29·0	45·8	58·6	64·4	58·2	45·0	26·4	0·0	−15·9	24·0	...
−22·6	−13·3	9·6	26·5	43·5	60·0	66·6	59·2	44·8	24·8	−0·8	−17·4	23·4	...
−33·0	−19·4	1·7	21·7	42·3	59·5	66·6	58·3	44·4	23·4	−9·3	−29·8	18·9	...
−45·0	−35·2	−11·7	14·7	40·1	58·3	65·8	59·8	42·0	15·6	−21·6	−41·0	11·9	...
−47·5	−29·0	−4·8	17·8	41·6	60·4	67·1	58·5	41·8	17·4	−24·0	−42·3	13·1	...
−61·2	−51·9	−29·8	4·0	32·4	51·4	58·6	48·7	32·7	−0·6	−39·5	−55·5	−1·3	...
−33·7	−36·4	−29·8	−7·0	14·8	32·0	40·8	38·3	32·4	5·7	−16·2	−28·3	1·0	...
−28·8	−20·0	−25·1	6·8	20·7	31·3	45·7	47·8	33·3	11·7	−4·7	−20·9	8·1	...
−35·7	−31·2	−25·1	−3·5	...	...	...	43·0	32·5	1·6	−31·2	−35·7	...	...
...	...	...	...	10·6	31·5	38·3	33·6	27·7	1·0	...	...	...	...
...	...	...	...	10·8	30·4	37·6	34·2	26·6	1·4	...	...	...	...
−29·7	−28·3	−10·3	15·3	29·3	50·2	55·2	51·1	38·0	11·1	−6·3	−25·6	12·5	...
−33·5	−24·3	−12·5	12·9	30·6	47·5	(51·3)	(45·5)	42·8	6·1	−8·2	−21·8	11·4	...
20·5	16·0	16·2	21·5	28·4	38·0	44·4	42·8	...	25·5	17·5	...	...	...
−11·2	−28·8	−4·0	1·7	31·6	42·6	...	...	...	13·8	−8·0	−21·6	...	...
−1·4	6·6	18·4	29·4	39·7	53·8	61·7	55·2	45·7	29·8	15·3	9·4	30·3	...
17·4	16·0	25·0	32·0	40·8	52·8	58·6	55·4	47·6	36·6	25·0	20·0	35·6	...
26·4	27·8	27·6	29·6	36·0	41·8	46·6	51·0	46·7	37·7	30·2	27·6	35·8	...
−11·8	−9·3	7·3	20·8	36·1	46·8	55·5	56·3	47·1	26·0	5·6	−10·2	22·5	...
−8·5	−0·9	13·4	24·2	34·9	44·7	54·2	52·3	44·4	24·5	8·0	−3·0	24·0	...
−18·3	−14·8	12·4	28·9	39·6	56·7	61·3	60·3	49·3	29·4	0·7	−22·0	23·6	...
9·9	11·1	22·8	35·4	42·8	51·1	57·9	62·4	55·7	46·0	30·0	16·7	36·9	...
−20·9	−10·3	10·2	32·2	47·3	61·0	66·7	60·8	48·2	30·0	4·8	−14·6	26·3	...
−13·4	−1·2	15·6	35·8	50·9	65·9	72·8	67·1	55·1	33·8	9·9	−8·7	32·1	...
−12·4	−2·2	14·6	36·2	50·7	64·8	71·2	68·5	55·9	35·8	12·0	−6·3	32·5	...
−9·2	−3·6	9·8	26·6	38·9	55·6	63·6	62·7	53·0	34·9	12·7	−5·1	28·2	...
4·6	8·8	18·3	30·5	42·3	52·0	60·0	61·6	53·3	40·4	21·2	8·0	33·4	...
7·2	9·0	19·7	30·6	42·7	50·8	57·6	66·4	53·9	43·5	28·0	14·5	35·6	...
10·0	16·2	28·3	38·7	47·8	56·7	65·8	68·4	59·0	44·8	27·6	11·8	39·6	...
7·4	13·4	27·3	38·6	49·3	58·3	66·8	70·0	61·5	48·6	29·1	12·4	40·2	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Askold,	Russia	10	1875–85	7 : 1, 9	42 44	132 21	84
Nemuro,	Japan	6	1881–86	6 : 2, 10	43 20	145 34	43
Sapporo,	do.	6	do.	do.	43 4	141 23	60
Hakodate,	do.	6	do.	do.	41 46	140 44	10
do.	do.	14	1859–63, '77–86	do.	41 46	140 44	10
Aomori,	do.	6	1881–86	do.	40 51	140 45	33
Akita,	do.	6	do.	do.	39 42	140 7	33
Miyako,	do.	6	do.	do.	39 38	141 59	100
Nobiru,	do.	6	do.	do.	38 23	141 12	15
Niigata,	do.	6	do.	do.	37 55	139 3	32
Kanazawa,	do.	6	do.	do.	36 33	136 40	95
Tokio,	do.	6	do.	do.	35 41	139 45	69
do.	do.	14	1872–86	do.	35 41	139 45	69
Numazu,	do.	6	1881–86	do.	35 6	138 51	30
Hamamatsu,	do.	6	do.	do.	34 42	137 43	92
Gifu,	do.	6	do.	do.	35 27	136 46	49
Kioto,	do.	6	do.	do.	35 1	135 46	162
Wakayama,	do.	6	do.	do.	34 14	135 9	49
Osaka,	do.	6	do.	do.	34 42	135 30	13
Sakai,	do.	6	do.	do.	35 33	133 13	7
Hiroshima,	do.	6	do.	do.	34 23	132 27	15
Kochi,	do.	6	do.	do.	33 33	133 34	20
Shimonoseki,	do.	6	do.	do.	33 58	130 57	135
Miyasaki,	do.	6	do.	do.	31 56	131 26	26
Kagoshima,	do.	6	do.	do.	31 35	130 33	13
Nagasaki,	do.	6	do.	do.	32 44	129 52	190
do.	do.	13	1871–78, '81–86	do.	32 44	129 52	190
Nafa,	Pelew	2	1856–58	6 : 1, 10	26 13	128 43	33
Wönsan,	Corea	2	1884, '87	6 : 2, 10	39 10	127 25	33
Fusan,	do.	2½	1884–86	do.	35 6	129 2	32
Chemulpho,	do.	1⅓	1884, '87	do.	37 29	126 33	290
Newchwang,	Manchuria	2	1861–62, '72	M.T.	40 57	122 13	[0]
Si-wan-tse,	China	2	1873–75	do.	40 59	115 18	3904
Pekin,	do.	15	1870–84	do.	39 57	116 28	123
Tien-Tsin,	do.	15	do.	do.	39 9	117 16	29
Taku,	do.	15	do.	do.	38 59	117 40	18
Tchang-kia-Tchouang,	do.	¾	1882–83	: 8	38 17	116 14	98
Sung-shu-chwang,	do.	1	1882–83	: 7	36 7	103 36	4870
I-tschang,	do.	1	1880	M.m.	30 39	111 10	500
Hankow,	do.	5	1877–81	do.	30 32	114 19	260
Kiu-kiang,	do.	4	1878–81	do.	29 44	116 8	180
Wuhu,	do.	3	1878–79, '81	do.	31 21	118 21	35
Shanghai,	do.	18	1847–64	do.	31 14	121 28	[0]
Zei-ki-wei,	do.	12	1873–84	M.T.	31 12	121 26	23
Foochow,	do.	1½	1886–87	do.	26 1	119 38	34
Kelung,	do.	2	1873–75	7 : 1, 9, 9	25 20	121 46	49
South Cape,	do.	1½	1886–87	M.T.	21 55	120 51	121
Hai-fung,	do.	...	...	...	22 53	115 15	
Canton,	do.	4	1829–31, '76	do.	23 12	113 17	39

Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years.	Corrs Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
10·3	16·3	28·4	37·4	48·3	57·7	66·0	69·0	61·1	48·0	28·8	12·5	40·2	...
23·6	21·1	26·4	36·0	43·6	51·0	60·5	65·0	59·2	50·0	39·9	28·6	42·1	...
20·5	21·8	27·8	40·0	50·2	58·8	67·2	69·9	60·9	48·6	36·2	24·2	43·8	...
27·9	27·2	31·8	42·2	49·6	57·7	65·7	70·4	63·0	52·1	39·7	30·6	46·5	...
27·4	28·7	34·3	43·7	51·8	58·9	66·7	70·1	64·1	53·0	41·3	31·8	47·6	...
27·6	26·9	32·1	43·4	51·9	61·3	69·4	72·9	64·8	52·6	40·5	30·2	47·8	...
30·7	30·0	34·8	46·6	55·5	64·0	72·5	74·8	67·2	54·3	42·8	33·8	50·6	...
31·8	31·2	35·0	45·1	53·0	59·8	67·4	71·8	64·9	53·6	43·5	33·8	49·2	...
32·5	32·8	36·7	47·0	55·3	63·2	72·0	75·8	69·2	56·2	45·5	35·9	51·8	...
34·8	34·4	38·1	49·1	57·2	64·9	74·1	77·3	70·0	58·9	47·8	37·7	53·7	...
35·3	34·9	39·9	50·6	58·6	67·1	74·6	77·5	70·3	59·5	48·4	40·3	54·8	...
36·7	37·4	42·3	53·3	60·5	68·2	74·7	77·4	70·8	60·3	49·2	40·2	55·9	...
36·4	37·8	43·8	53·6	62·0	68·4	76·1	77·6	70·9	59·3	48·6	41·0	56·3	...
40·4	40·4	45·3	55·3	62·1	69·1	75·4	77·4	72·4	63·3	52·5	43·3	58·1	...
39·8	40·4	45·2	55·8	62·7	69·3	76·0	78·1	72·8	64·0	52·5	43·0	58·3	...
36·0	37·3	42·6	53·9	62·1	69·8	77·5	78·9	72·1	62·1	49·2	39·5	56·8	...
35·9	36·5	41·4	53·1	61·0	70·2	77·2	79·0	72·3	61·5	48·4	38·8	56·3	...
39·7	39·4	44·7	56·1	63·0	70·9	77·9	80·1	74·3	63·3	52·0	43·9	58·8	...
37·9	37·9	43·0	54·5	62·6	70·5	78·4	80·2	73·4	62·6	50·4	41·4	57·7	...
38·3	37·6	43·0	52·5	60·1	68·0	76·0	78·8	71·2	61·5	50·3	41·7	56·6	...
38·0	38·5	43·5	54·0	62·2	69·5	77·5	79·7	73·6	62·6	50·4	41·2	57·6	...
41·2	43·3	47·6	58·3	64·6	70·8	76·6	78·1	74·5	65·1	53·1	43·3	59·7	...
40·8	40·3	45·3	53·8	61·5	68·2	76·0	78·8	73·0	64·0	53·1	44·4	58·3	...
43·3	43·5	49·7	59·4	65·4	72·3	77·8	79·0	74·0	65·4	53·6	45·0	60·7	...
43·6	43·8	51·0	60·3	65·7	72·1	78·6	79·7	75·0	66·6	55·2	45·6	60·8	...
41·8	41·4	47·3	57·6	63·8	70·4	77·7	79·8	74·3	64·8	53·4	44·4	59·8	...
42·0	43·1	49·5	58·9	65·7	71·8	80·5	80·3	75·2	66·0	54·5	46·0	61·1	...
61·0	60·3	64·2	68·7	75·4	79·3	83·5	81·9	80·6	77·9	69·8	64·9	72·3	...
28·3	31·6	40·6	51·2	61·0	65·1	63·3	73·5	67·4	56·8	44·2	33·0	50·2	...
33·0	33·8	43·5	52·6	60·4	66·6	73·4	76·8	70·8	60·3	46·9	36·1	54·5	...
23·9	28·0	36·5	50·0	61·9	65·7	76·3	78·1	68·1	59·2	40·9	29·1	51·5	...
10·4	18·5	31·8	47·5	60·3	71·5	77·7	75·4	65·4	50·5	37·6	19·4	47·2	...
2·5	11·7	27·1	38·1	52·9	63·6	65·2	65·2	52·9	39·0	20·1	12·6	37·5	...
23·4	28·6	41·5	56·9	68·7	77·3	79·3	76·9	67 6	54·7	37·7	26·7	53·3	...
26·9	30·0	44·0	56·2	68·6	77·7	81·2	78·5	70·0	58·4	40·6	29·7	55·2	...
23·4	30·2	40·8	57·7	68·3	77·0	77·4	77·4	67·8	54·0	38·7	28·3	53·4	...
26·2	28·0	41·0	56·5	68·5	79·7	...	...	...	57·4	38·1	24·4	...	...
17·8	23·3	39·6	55·8	...	...	...	...	...	46·0	36·9	21·7	...	...
39·6	41·9	55·6	62·1	73·9	78·4	80·4	79·0	75·0	70·0	56·0	43·5	63·0	...
37·9	41·0	50·0	61·7	71·4	78·4	84·0	83·5	77·2	65·3	54·3	42·4	62·2	...
37·4	42·6	50·5	61·9	72·7	77·9	85·3	84·7	77·5	66·7	55·0	43·3	63·1	...
39·0	44·8	49·1	58·5	68·5	75·2	82·0	82·8	76·1	63·9	53·4	42·3	61·3	...
38·3	39·4	46·5	56·6	65·6	73·7	82·3	81·9	74·3	64·6	51·4	42·3	59·7	...
36·9	39·7	46·6	57·0	66·4	73·8	81·1	80·2	73·8	63·7	51·1	41·4	59·4	...
50·6	48·8	(58·0)	62·7	67·5	76·0	80·4	80·8	74·7	68·8	62·1	52·4	65·5	...
57·9	58·6	62·0	66·4	74·6	81·6	82·9	81·9	79·8	74·0	66·6	62·8	70·8	...
69·0	68·3	(69·8)	71·9	76·2	79·5	79·9	78·2	77·2	77·3	72·2	69·0	74·0	...
61·7	63·9	66·7	74·7	82·0	84·7	84·5	84·6	83·3	79·2	73·0	69·1	75·6	...
54·6	57·6	64·5	70·4	76·5	82·8	82·3	81·2	79·0	73·8	64·0	56·6	70·3	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Hong Kong, .	China	15	1870–84	M.m.	22 18	114 10	43
Victoria Peak, .	do.	15	do.	do.	22 0	114 0	1816
Cape Aguilar, .	do.	15	do.	do.	22 12	114 18	170
Macao, . .	do.	15	do.	M.T.	22 11	113 32	26
Hanoi, . . .	Tonquin	$1\frac{2}{3}$	1877–79	6 : 3, 10	21 1	105 48	45
Hué, . . .	do.	6	1881–86	M.T.	16 33	107 38	20
Tuguegaras, .	Philippine Islands	2	1881–82	do.	17 37	121 30	125
Manila, . .	do.	15	1870–84	do.	14 35	120 59	54
Ilo Ilo, . .	do.	$1\frac{1}{2}$	1863–65	do.	9 30	123 30	0
Hatzfeldthafen, .	East Indies	1	1886–87	do.	–4 24	145 14	10
Moresby Bay, .	do.	$1\frac{3}{4}$	1875–76	do.	–9 32	146 10	278
Solomon Island, .	do.	$\frac{2}{3}$	1882–84	do.	–6 0	156 0	0
Bismarck Island, .	do.	2	1883–84	thrice daily	–4 20	152 30	[0]
Amboina, . .	do.	5	1850–54	6, 9 : 3, 10	–3 45	128 15	39
Bandjermassing, .	do.	8	1851–58	do.	–3 0	114 30	10
Banjoewangi, .	do.	8	1850–57	do.	–8 17	114 27	26
Buitenzorg, . .	do.	8	1848–55	do.	–6 37	106 49	910
Batavia, . .	do.	15	1870–84	hourly	–6 11	106 50	23
Samarang, . .	do.	$1\frac{1}{4}$	?	8, N. : 4, 8	–6 57	110 30	20
Bogodjampie, .	do.	$2\frac{1}{6}$	?	?	–8 24	114 24	279
Palembang, . .	do.	6	1850–53, '55–56	6, 9 : 3, 10	–2 50	104 53	20
Padang, . .	do.	4	1850–53	do.	–0 56	100 2	240
Lahat, . . .	do.	8	1845–52	6, N. : 7	–3 12	104 36	823
Saigon, . .	Cochin China	6	1874–79	M.m.	10 47	106 42	10
Bankok, . .	Siam	10	1858–67	M.T.	13 38	100 27	[0]
Singapore, . .	Malay Peninsula	15	1870–84	M.m.	1 15	103 31	24
Raffles Lighthouse,	do.	2	1866–67	do.	1 9	103 44	65
Malacca, . .	do.	2	1885–86	do.	2 10	102 14	12
Kwala Lumpor, .	do.	1	1884	9 : 9	3 10	101 51	177
Wellesley, . .	do.	2	1885–86	M.m.	5 22	100 30	43
Penang, . .	do.	2	1885–86	do.	5 24	100 20	20
Nancowry, . .	India	15	1870–84	M.T.	8 0	93 46	81
Port Blair, . .	do.	15	do.	do.	11 41	92 42	61
Mergui, . .	do.	15	do.	do.	12 11	98 38	96
Moulmein, . .	do.	15	do.	do.	16 29	97 40	94
Diamond Island, .	do.	15	do.	do.	15 52	94 19	41
Bassein, . .	do.	15	do.	do.	16 4	94 50	35
Rangoon, . .	do.	15	do.	do.	16 46	96 12	41
Toungoo, . .	do.	15	do.	do.	18 57	96 24	169
Thayetmyo, . .	do.	15	do.	do.	19 22	95 12	134
Akyab, . .	do.	15	do.	do.	20 28	92 57	20
Chittagong, . .	do.	15	do.	do.	22 21	91 50	87
Saugor Island, .	do.	15	do.	do.	21 39	88 5	25
Calcutta, . .	do.	15	do.	do.	22 32	88 20	21
Berhampore, .	do.	15	do.	do.	24 6	88 17	66
Dacca, . .	do.	15	do.	do.	23 43	90 27	35
Silchar, . .	do.	15	do.	do.	24 49	92 50	104
Sibsagar, . .	do.	15	do.	do.	26 59	94 40	333
Goalpara, . .	do.	15	do.	do.	26 11	90 40	395
Darjeeling, . .	do.	17	1868–84	do.	27 3	88 18	7421

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
59·6	59·8	64·3	73·0	79·6	83·5	84·5	83·8	82·3	78·3	70·2	62·7	73·5	...
53·0	53·6	60·0	67·9	73·2	76·0	77·8	77·4	75·6	72·0	63·8	56·5	67·2	...
58·6	59·6	63·6	70·7	77·1	81·4	83·2	83·2	81·2	77·8	69·8	62·5	72·4	...
61·4	60·6	65·2	73·3	81·0	84·5	85·2	85·0	83·9	80·8	70·4	63·7	74·0	...
60·1	62·3	66·2	76·1	83·8	88·5	87·6	85·1	80·8	78·2	72·1	66·9	75·6	...
67·1	67·5	71·6	75.4	84·0	83·8	83·1	83·5	79·7	79·3	72·1	67·0	76·2	...
72·6	73·9	75·3	77·7	81·9	82·3	81·9	81·1	80·0	77·7	76·1	73·6	77·8	...
76·9	78·2	80·6	83·1	84·0	82·1	80·2	80·0	79·8	79·6	78·8	77·0	80·0	...
77·0	76·1	77·2	79·3	80·1	80·6	79·3	79·0	80·2	78·3	79·0	77·9	78·7	...
80·0	80·2	79·7	79·4	79·0	78·3	78·9	79·6	79·7	79·4	79·5	79·4	79·4	...
82·3	83·6	82·1	81·9	81·2	80·4	79·0	78·8	79·2	80·9	82·8	82·8	81·3	...
...	...	...	83·0	84·6	82·6	81·9	81·9	81·9	82·0	81·5	...	...	...
76·6	78·2	76·7	75·2	77·7	77·2	76·2	75·9	75·7	76·2	77·0	77·5	76·6	...
80·5	80·7	80·5	79·5	79·0	78·0	77·1	77·3	77·7	79·0	80·5	80·7	79·2	...
80·2	80·4	80·8	81·3	81·5	80·9	79·4	80·0	80·8	81·3	80·9	79·9	80·6	...
80·1	79·8	80·6	81·1	80·0	80·0	78·5	78·4	79·1	80·4	80·4	80·3	79·9	...
76·4	75·5	76·5	77·3	77·4	76·7	75·7	76·7	77·7	78·0	77·4	78·9	76·9	...
77·5	77·6	78·5	79·3	79·4	78·6	78·1	78·5	79·2	79·1	79·2	78·1	78·6	...
78·6	79·3	78·8	80·8	80·4	79·2	78·4	80·1	80·8	81·9	81·3	79·7	79·9	...
79·2	78·8	78·8	78·4	77·5	74·8	72·3	75·0	77·9	79·3	79·3	79·5	77·5	...
79·7	80·0	80·7	80·7	81·1	80·3	80·0	79·9	81·0	80·8	80·6	79·8	80·4	...
79·6	79·7	80·0	80·2	80·8	80·2	79·7	79·3	79·6	79·1	79·1	79·3	79·7	...
79·3	80·1	81·0	81·5	81·1	80·8	80·6	80·2	80·2	81·1	80·3	79·5	80·5	...
77·5	80·1	83·3	83·7	84·9	81·5	81·5	81·0	80·6	80·6	79·2	77·7	81·0	...
76·1	79·1	82·5	83·4	82·3	82·3	81·4	81·4	80·3	80·1	76·8	74·8	80·1	...
80·1	82·6	84·4	83·6	82·4	82·4	81·6	80·4	82·4	82·6	81·3	79·5	82·0	...
79·8	78·7	80·3	80·8	81·1	80·9	80·4	80·3	80·3	80·0	81·3	79·6	80·3	−3·0
81·7	82·2	83·4	82·8	82·2	82·0	82·4	81·6	82·1	81·8	81·8	80·6	82·1	...
76·5	77·9	78·9	78·5	79·7	79·0	78·2	78·6	78·3	77·9	77·4	76·2	78·1	...
83·6	83·9	85·0	86·0	84·2	83·2	82·8	82·5	81·8	82·4	81·7	81·8	83·1	...
82·6	83·5	85·1	85·0	83·6	82·8			80·0	80·9	80·6	80·9	82·5	...
79·4	80·8	81·1	82·6	81·2	80·6				78·8	79·0	78·8	80·1	...
79·4	80·1	81·9	83·5	81·1	80·3					80·0	79·4	80·4	...
76·6	78·4	80·2	80·0	80·4	77·1						76·1	77·7[1]	...
75·2	77·7	81·6	82·9	81·8	78·3							78·7	...
75·6	77·0	79·7	81·6	82·0	80·								
71·8	74·8	80·1	82·0	82·0	79·								
75·1	77·6	81·4	83·6	82·5	79								
70·5	73·7	80·1	84·2	83·1	79								
68·6	72·8	82·0	87·0	86·5	8								
69·6	72·8	78·9	83·4	84·1									
67·5	70·7	77·5	81·6	82·0									
67·4	72·9	80·0	83·8	85·0									
66·6	72·0	79·6	84·2	84·6									
64·6	69·2	78·3	85·3	84.7									
66·6	71·5	79·4	83·0	83·3									
63·5	67·0	73·4	78·0	79·5									
58·9	62·6	68·2	74·0	78·2									
62·8	67·2	74·2	77·5	78·									
39·5	40·9	47·9	53·8	55·									

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PETROLOGY OF OCEANIC ISLANDS.
PART VII.
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PART V.
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G. TAIT.

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Purneah, . .	India	15	1870–84	M.T.	25	50	87	34	125
Gya, . . .	do.	15	do.	do.	24	42	85	2	375
Hazaribagh, .	do.	15	do.	do.	24	0	85	24	2007
Patna, . .	do.	15	do.	do.	25	37	85	14	183
Gorakhpur, . .	do.	15	do.	do.	26	46	83	18	256
Benares, . .	do.	15	do.	do.	25	20	83	2	267
Allahabad, . .	do.	15	do.	do.	25	26	81	52	307
Lucknow, . .	do.	15	do.	do.	26	50	81	0	369
Bareilly, . .	do.	15	do.	do.	28	21	79	27	568
Ludhiana, . .	do.	15	do.	do.	30	55	75	54	812
Sirsa, . . .	do.	15	do.	do.	29	32	75	6	662
Chakrata, . .	do.	17	1868–84	do.	30	40	77	55	7052
Roorkee, . .	do.	15	1870–84	do.	29	52	77	56	887
Delhi, . . .	do.	15	do.	do.	28	40	77	16	718
Jeypore, . .	do.	15	do.	do.	26	55	75	50	1431
Ajmere, . .	do.	15	do.	do.	26	28	74	37	1611
Neemuch, . .	do.	15	do.	do.	24	25	75	0	1639
Agra, . . .	do.	15	do.	do.	27	10	78	5	555
Jhansi, . .	do.	15	do.	do.	25	27	78	37	855
Raipur, . .	do.	15	do.	do.	21	15	81	41	960
Sambalpur, . .	do.	15	do.	do.	21	31	84	1	463
Cuttack, . .	do.	15	do.	do.	20	9	85	54	80
False Point, . .	do.	15	do.	do.	20	0	86	47	21
Visagapatam, .	do.	15	do.	do.	17	42	83	22	31
Sironcha, . .	do.	15	do.	do.	18	51	80	0	401
Chanda, . .	do.	15	do.	do.	19	56	79	19	652
Nagpur, . .	do.	15	do.	do.	21	9	79	11	1025
Akola, . . .	do.	15	do.	do.	20	42	77	4	930
Secunderabad, .	do.	15	do.	do.	17	27	78	33	1787
Masulipatam, .	do.	15	do.	do.	16	9	81	12	10
Sholapur, . .	do.	15	do.	do.	17	41	75	56	1590
Bellary, . .	do.	15	do.	do.	15	9	76	57	1455
Bangalore, . .	do.	15	do.	do.	12	59	77	38	2981
Madras, . .	do.	15	do.	do.	13	4	80	14	22
Salem, . . .	do.	15	do.	do.	11	39	78	12	940
Negapatam, . .	do.	15	do.	do.	10	46	79	53	15
Trichinopoly, .	do.	15	do.	do.	10	50	78	44	275
Madura, . .	do.	15	do.	do.	9	55	78	10	448
Jaffna, . . .	do.	15	do.	do.	9	40	79	56	9
Trincomalee, .	do.	15	do.	do.	8	33	81	15	175
Batticaloa, . .	do.	15	do.	do.	7	43	81	44	26
Hambantota, .	do.	15	do.	do.	6	7	81	7	40
Galle, . . .	do.	15	do.	do.	6	1	80	14	48
Colombo, . .	do.	15	do.	do.	6	56	79	52	40
Putalem, . .	do.	15	do.	do.	8	0	80	5	[0]
Kandy, . .	do.	15	do.	do.	7	18	80	40	1696
Newera Eliya, .	do.	15	do.	do.	6	46	80	47	6240
Amina Divi, .	do.	1½	1885–86	do.	11	6	72	48	15
Cochin, . .	do.	15	1870–84	do.	9	58	76	17	11
Coimbatore, . .	do.	15	do.	do.	11	0	77	0	1348

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
62·3	66·7	76·1	84·0	83·7	84·7	84·0	84·0	83·3	79·6	71·2	63·4	76·2	...
64·3	69·6	80·5	89·5	91·8	89·3	84·5	83·9	84·2	80·2	71·5	64·5	79·5	...
61·0	65·2	74·8	83·5	85·3	82·4	78·4	77·7	77·7	74·0	67·0	61·0	74·0	...
61·0	66·0	77·6	86·8	88·5	88·0	84·8	84·1	84·0	79·6	70·2	62·4	77·7	...
60·3	65·2	76·2	85·8	87·8	87·9	84·1	83·7	83·8	79·0	69·0	61·7	77·0	...
61·0	66·2	77·3	87·0	91·3	91·3	85·0	84·3	83·3	78·0	68·3	60·8	78·0	...
60·6	65·6	78·2	87·8	92·3	91·2	85·0	83·8	83·0	77·6	67·6	60·6	77·8	...
60·5	66·2	76·9	87·4	91·8	91·9	86·3	85·4	84·5	78·7	68·5	60·8	78·2	...
57·2	62·3	72·5	83·2	88·0	89·0	84·7	83·3	82·3	76·0	65·3	57·7	75·1	...
52·0	57·4	67·8	78·2	85·5	90·5	86·7	85·8	82·6	74·8	62·3	54·1	73·1	...
55·8	60·0	71·3	82·3	89·2	93·6	88·8	88·3	85·0	78·0	64·4	56·8	76·1	...
42·4	43·3	51·1	59·9	64·6	67·3	64·2	64·1	63·0	57·7	51·2	46·3	56·3	...
56·4	60·6	70·5	81·9	87·8	90·0	84·5	83·7	82·4	75·0	64·0	56·9	74·5	...
58·3	62·5	74·4	84·6	89·7	93·5	86·8	86·1	84·1	78·3	67·8	60·1	77·2	...
60·8	63·6	76·0	85·3	90·2	90·6	84·1	82·0	82·5	77·5	69·1	61·8	77·0	...
57·8	61·5	72·3	83·4	89·2	87·5	82·2	79·7	80·8	74·6	66·0	58·8	74·5	...
62·2	65·3	75·7	84·0	88·8	86·8	79·0	78·2	77·7	75·8	67·2	62·8	75·3	...
60·2	65·3	76·7	88·1	93·9	94·4	87·0	85·3	84·3	79·6	69·5	61·8	78·8	...
63·2	68·0	78·8	89·0	94·9	93·1	83·8	82·7	82·4	80·5	72·8	64·6	79·5	...
66·8	71·9	79·9	88·9	92·4	85·5	78·8	79·1	79·5	77·0	70·0	65·8	78·0	...
67·3	72·6	80·6	89·2	92·9	87·5	80·5	80·5	81·6	79·2	71·6	66·2	79·2	...
71·5	76·0	83·0	87·4	88·6	86·2	83·2	83·2	83·1	81·3	75·0	70·0	80·7	...
67·0	72·3	78·0	81·8	83·5	83·6	81·5	81·3	81·4	79·2	72·2	66·0	77·3	...
75·8	78·8	83·3	86·3	87·8	87·7	85·2	85·3	84·7	83·3	79·3	75·2	82·7	...
71·0	77·8	85·4	91·8	93·9	87·3	80·8	80·2	80·6	79·2	72·8	69·3	80·8	...
68·5	74·2	82·2	89·6	93·2	86·7	80·0	79·7	79·3	76·7	69·9	66·0	78·8	...
68·4	73·6	82·0	88·8	93·0	85·8	79·1	79·3	79·0	77·1	70·6	67·0	78·6	...
68·4	73·1	81·6	89·0	93·1	85·5	79·4	79·1	78·3	76·3	70·4	66·3	78·4	...
70·0	75·7	82·1	87·1	88·8	82·0	77·2	77·2	76·3	76·0	71·8	69·0	77·8	...
74·7	76·8	80·8	84·7	88·0	87·2	84·0	83·6	82·6	81·0	77·4	74·3	81·3	...
71·6	76·8	83·4	86·2	89·0	81·2	78·6	77·8	77·0	77·2	73·6	70·0	78·5	...
73·1	78·5	85·4	89·1	88·0	83·2	80·7	80·8	79·9	78·9	75·2	72·2	80·4	...
67·3	71·8	76·8	80·1	78·5	74·2	72·2	72·1	71·9	71·8	69·7	67·3	72·8	...
75·9	76·3	81·3	84·6	87·2	87·2	85·2	84·4	83·5	80·8	77·7	75·9	81·7	...
75·5	78·8	83·8	86·6	85·2	82·7	81·2	80·5	80·3	78·9	76·8	75·0	80·4	...
76·4	78·0	81·8	84·8	85·9	85·6	84·3	83·2	82·6	81·0	78·3	76·3	81·5	...
75·7	78·5	83·2	87·3	87·7	86·3	85·2	83·9	83·1	80·5	77·7	75·5	82·1	...
77·1	79·2	82·8	85·7	85·6	85·0	84·5	83·4	82·9	80·8	78·7	76·9	81·9	...
78·0	79·5	83·2	85·8	85·5	84·2	83·2	82·9	82·8	82·0	79·8	78·0	82·1	...
78·4	79·8	81·9	84·5	85·2	85·0	84·9	84·4	83·4	81·6	79·2	78·3	82·2	...
78·0	79·0	81·2	83·6	84·6	85·1	84·7	83·9	83·4	81·9	79·6	78·2	81·9	...
78·8	79·7	81·0	82·7	82·0	81·6	81·2	80·8	80·7	80·6	79·7	79·1	80·7	...
78·2	79·6	81·2	82·0	81·8	80·6	79·9	80·0	80·1	79·8	79·2	78·5	80·1	...
79·5	80·5	82·0	83·2	82·9	81·6	81·1	80·9	81·8	80·7	80·2	79·8	81·1	...
77·2	78·4	81·3	82·9	82·7	81·3	81·0	80·8	81·0	80·4	78·8	77·4	80·3	...
74·1	76·1	78·7	79·1	78·9	76·5	75·7	75·8	75·9	75·9	75·4	74·5	76·4	...
57·4	57·3	58·9	60·0	61·2	59·3	58·4	58·8	58·7	59·0	58·7	58·0	58·8	...
79·6	80·3	82·2	(83·0)	84·1	81·6	79·4	80·3	80·4	80·3	80·1	79·3	80·9	...
78·7	80·2	82·5	83·8	81·9	78·4	77·3	77·7	78·1	78·8	79·4	78·8	79·6	...
73·8	77·0	81·2	83·2	81·3	78·1	76·8	76·9	77·2	77·0	75·6	73·8	77·6	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Mangalore, . .	India	15	1870–84	M.T.	12	52	74	54	52
Karwar, . .	do.	15	do.	do.	14	50	74	15	44
Goa, . . .	do.	15	do.	do.	15	21	73	56	23
Belgaum, . .	do.	15	do.	do.	15	52	74	42	2550
Ratnagiri, . .	do.	15	do.	do.	17	6	73	23	110
Poona, . . .	do.	15	do.	do.	18	28	74	10	1849
Bombay, . .	do.	15	do.	do.	18	54	72	49	37
Surat, . . .	do.	15	do.	do.	21	13	72	46	36
Malegaon, . .	do.	15	do.	do.	20	34	74	22	1430
Khandwa. . .	do.	15	do.	do.	21	49	76	23	1024
Hoshangabad, .	do.	15	do.	do.	22	45	77	46	1020
Jubbulpore, . .	do.	15	do.	do.	23	9	79	59	1341
Indore, . .	do.	15	do.	do.	22	46	75	53	1825
Deesa, . . .	do.	15	do.	do.	24	16	72	14	466
Rajkot, . .	do.	15	do.	do.	22	17	70	52	429
Bhuj, . . .	do.	15	do.	do.	23	15	69	42	395
Kurrachee, . .	do.	15	do.	do.	24	47	67	4	49
Hyderabad, . .	do.	15	do.	do.	25	25	68	27	134
Pachpadra, . .	do.	15	do.	do.	25	55	72	18	380
Jacobabad, . .	do.	15	do.	do.	28	24	68	18	186
Bikaneer, . .	do.	15	do.	do.	27	59	73	14	744
Mooltan, . .	do.	15	do.	do.	30	10	71	33	420
Lahore, . .	do.	15	do.	do.	31	34	74	20	732
Ludhiana, . .	do.	15	do.	do.	30	55	75	54	812
Sialkot, . .	do.	15	do.	do.	32	29	74	35	829
Rawalpindi, . .	do.	15	do.	do.	33	38	73	5	1652
Peshawar, . .	do.	15	do.	do.	34	2	71	37	1110
Murree, . .	do.	15	do.	do.	33	54	73	27	6344
Dera Ismail Khan,	do.	15	do.	do.	32	0	71	5	573
Quetta, . .	Beloochistan	8	1868–85	do.	30	11	67	3	5500
Kaschgar, . .	Turkestan	$\frac{5}{6}$	1886–87	do.	39	25	76	7	4000
Yarkand, . .	do.	1	1874–75	do.	38	25	77	16	4124
Bushire, . .	Persia	9	1878–86	do.	28	59	50	49	25
Shiraz, . .	do.	1	1884–85	M.m.	29	39	52	40	4500
Teheran, . .	do.	3	1884–86	7 : 1, 9	51	25	35	41	3714
Do. . .	do.	3	do.	do.	51	25	35	41	4739
Mosul, . . .	Turkey in Asia	2	1854–55	M.m.	36	22	43	14	400
Bagdad, . .	do.	1	1861–62	do.	33	21	44	26	40
Pawana, . .	do.	$\frac{1}{2}$	do.	do.	31	10	45	15	[0]
Muscat, . .	Arabia	$3\frac{3}{4}$	1872–75, '84, '85	M.T.	23	38	58	36	32
Aden, . . .	do.	$4\frac{1}{2}$	1880–84	do.	12	45	45	3	94
Djedda, . .	do.	6	1881–86	do.	21	30	39	22	20
Jerusalem, . .	Syria	19	1863–81	M.m.	31	47	35	13	2400
Damascus, . .	do.	1	?	do.	33	32	36	20	2352
Beyrout, . .	do.	11	1876–86	do.	35	28	33	54	112
Larnaca, . .	Cyprus	4	1863–67	do.	34	55	33	39	25
Do. . .	do.	4	do.	do.	34	55	33	39	300
Trebizonde, . .	Asia Minor	15	1870–84	do.	44	1	39	45	92
Do. . .	do.	3	1843–44, '48, '49	do.	44	1	39	45	108
Samsoun, . .	do.	$1\frac{1}{2}$	1880–82	do.	41	18	36	21	26

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
76·5	77·7	81·0	83·2	82·6	78·2	76·8	76·8	77·0	77·8	78·6	77·2	78·6	...
75·4	75·8	80·6	81·7	83·2	78·7	77·8	77·0	76·9	77·7	77·0	75·9	78·1	...
79·4	81·6	83·2	85·0	86·1	82·4	80·0	79·3	79·3	80·7	82·8	82·1	81·8	...
71·9	76·3	79·9	80·8	79·8	73·7	70·8	70·2	70·7	74·1	73·6	71·6	74·4	...
74·9	75·3	78·7	82·1	83·7	80·2	78·7	78·1	77·9	78·8	77·3	75·1	78·4	...
71·8	76·7	82·8	85·7	85·0	79·2	75·1	74·8	75·0	77·7	75·6	71·8	77·6	...
73·8	75·1	79·0	82·1	84·3	83·0	80·6	79·9	79·6	80·4	78·6	76·0	79·4	...
69·8	72·7	79·4	84·5	85·7	84·2	81·0	80·8	79·8	79·7	74·5	70·4	78·5	...
67·4	72·1	79·8	85·3	87·8	82·7	78·2	77·4	76·5	76·0	70·1	66·0	76·6	...
67·0	71·4	80·1	87·5	92·2	87·0	79·4	78·7	78·5	76·7	69·8	65·5	77·8	...
65·8	70·2	79·5	87·8	92·6	87·5	79·1	78·5	79·3	77·0	70·2	65·9	77·8	...
61·8	66·3	75·9	84·8	90·6	86·4	78·8	78·2	78·5	74·0	65·5	60·9	75·1	...
63·7	67·0	75·5	82·7	87·8	83·3	76·4	76·0	75·4	73·9	65·8	61·7	74·1	...
67·1	71·5	81·3	87·8	92·4	90·0	83·0	81·5	81·6	80·3	73·7	69·3	80·0	...
66·3	70·4	77·9	84·0	88·3	86·3	81·6	80·4	79·6	80·0	72·3	67·1	77·8	...
66·7	69·2	78·8	83·4	87·1	86·0	82·4	81·0	81·1	81·7	73·6	67·9	78·2	...
65·2	68·8	76·4	80·2	85·7	86·6	83·6	81·7	81·8	79·8	72·5	67·9	77·5	...
63·2	67·1	77·3	85·8	91·4	90·7	87·2	85·0	84·9	82·9	72·5	63·8	79·3	...
60·3	63·6	74·4	85·4	92·0	92·3	87·5	83·4	84·3	80·2	68·4	61·8	77·8	...
57·3	62·8	73·3	83·4	92·0	96·2	93·0	90·0	87·1	78·8	66·5	58·6	78·2	...
60·6	61·2	76·4	87·6	94·0	95·4	89·3	86·8	86·5	83·9	72·1	62·5	79·7	...
54·6	58·6	70·4	79·9	88·7	94·4	91·5	88·7	86·4	77·0	66·0	56·4	76·1	...
54·6	58·7	70·1	81·5	88·5	93·5	89·3	87·6	84·9	76·9	65·0	55·4	75·5	...
52·3	57·1	67·7	78·4	85·6	90·7	86·0	85·7	82·8	74·8	62·4	54·1	73·1	...
52·3	56·2	66·0	77·4	85·0	90·8	86·6	84·8	83·2	74·6	62·4	53·0	72·7	...
49·1	51·8	61·9	71·8	81·2	89·1	86·8	83·6	80·5	69·7	57·5	50·3	69·4	...
50·6	52·6	62·1	71·3	81·8	89·4	88·7	87·3	81·5	71·0	58·0	50·6	70·4	...
39·0	39·4	48·7	57·6	65·2	71·7	68·2	66·5	65·5	59·0	49·4	43·4	56·1	...
52·3	56·4	66·4	77·3	87·1	93·0	91·2	89·5	85·9	75·0	61·7	53·7	74·1	...
41·2	40·9	50·4	58·1	67·2	74·0	77·2	74·8	67·6	55·8	44·8	41·3	57·8	...
19·2	29·7	44·2	64·4	66·0	72·9	80·4	...	...	55·2	37·8	26·4	...	...
21·2	31·6	40·8	64·0	69·8	75·7	81·7	74·7	66·6	56·1	38·8	24·3	54·1	...
57·5	57·5	62·8	71·4	80·9	84·3	88·6	88·8	84·6	77·7	69·0	61·2	73·6	...
42·6	44·5	52·5	60·6	70·5	78·0	83·5	80·0	75·0	65·0	54·5	47·0	62·8	...
36·0	38·7	49·1	57·4	66·3	...	...	...	...	63·7	52·6	43·6	...	...
...	...	..	...	...	70·6	74·5	73·9	67·0	54·3	...	...	...	...
45·2	50·8	53·0	61·6	76·4	88·6	93·2	93·0	80·8	72·2	56·4	52·1	68·6	...
49·5	56·5	62·6	73·6	87·3	91·0	94·8	93·4	86·2	76·6	64·8	51·8	73·9	...
52·2	54·5	...	...	...	...	...	...	85·8	78·3	66·4	64·0	...	...
68·6	69·8	75·0	80·8	89·9	91·8	88·3	86·9	85·3	84·0	77·1	70·2	80·6	...
75·2	75·9	78·4	81·7	85·2	86·5	84·9	84·8	86·2	81·8	77·5	75·6	81·2	...
71·1	69·3	73·2	77·7	81·1	83·8	85·6	86·5	84·4	81·5	78·3	75·2	79·0	...
47·8	48·4	54·3	60·5	68·4	73·0	74 1	75·5	72·7	69·3	60·1	51·8	63·0	...
45·5	46·9	55·7	59·2	72·2	78·1	80 8	78·5	72·0	67·7	55·6	50·8	64·0	...
56·7	55·4	59·4	64·4	69·4	75·6	79·0	80·8	78·8	73·4	65·8	60·4	68·3	...
...	...	...	...	...	78·7	80·5	81·5	77·9	...	...	...	...	...
53·7	52·8	58·5	60·9	71·2	...	...	...	...	68·1	60·9	54·4	...	...
41·4	43·9	46·4	52·7	64·8	68·2	74·8	71·7	66·9	64·0	55·0	49·3	58·3	...
44·2	46·8	48·6	54·0	61·8	70·0	74·8	75·6	69·6	65·3	58·8	48·0	59·9	...
45·2	43·9	46·4	51·8	57·4	67·3	73·0	73·4	71·4	62·6	54·7	46·4	57·8	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	Latitude. ′	Longitude. °	Longitude. ′	Height, Feet.
Scutari,	Asia Minor	15	1870–84	M.m.	41	0	29	3	60
Smyrna,	do.	7	1864–70	do.	38	26	27	10	25
Tarsus,	do.	4	1841–42, '49, '54–'55	?	36	46	34	44	0
Brousse,	do.	1½	?	S.R.: 2, 9	40	5	29	1	1000
La Canée,	Crete	6½	1879–85	M.m.	35	30	24	0	112
Red Sea,*	...	...	...	...	29	0	33	0	...
Do.	...	...	...	...	27	0	34	20	...
Do.	...	...	...	...	25	0	35	40	...
Do.	...	...	...	...	23	0	37	0	...
Do.	...	...	...	...	21	0	38	10	...
Do.	...	...	...	...	19	0	39	30	...
Do.	...	...	...	...	17	0	40	40	...
Do.	...	...	...	...	15	0	42	0	...
Do.	...	...	...	...	13	0	43	10	...
Do.	...	...	...	...	12	40	45	0	...
Do.	...	...	...	...	12	45	47	0	...
Do.	...	...	...	...	12	50	49	0	...
Assab,	Abyssinia	1	1882	9 : 9	12	59	42	45	41
Massuah,	do.	2½	1885–87	9 : 9, M.m.	15	36	37	26	31
Condar,	do.	2	1832–33	7 : 2½	12	36	37	32	7422
Keneh,	Egypt	1	?	?	26	0	33	40	100
Kosseir,	do.	1	1872–73	M.T.	26	5	34	16	[0]
Suez,	do.	5½	1880–85	M.m.	29	59	32	31	24
Ismailia,	do.	5½	do.	do.	30	36	32	16	29
Port Said,	do.	5½	do.	do.	31	16	32	18	20
Alexandria,	do.	15	1870–84	9 : 9, M.m.	31	12	29	53	62
Cairo,	do.	14	1868–81	three hourly	30	5	31	17	108
Bengasi,	Barca	1	1882	9 : 9	32	7	20	3	33
Tripoli,	Tripoli	4	1819–21, '55	M.T.	32	53	13	11	98
Aigila,	do.	1½	?	S.R.: 3	29	0	22	5	130
Tunis,	Tunis	⅔	1883–84	M.T.	36	42	10	13	46
Le Calle,	Algeria	15	1870–84	do.	36	54	8	26	35
Gulema,	do.	15	do.	do.	36	28	7	27	917
Constantine,	do.	15	do.	do.	36	22	6	36	2165
Bougie,	do.	15	do.	do.	36	47	5	5	219
Algiers,	do.	15	do.	do.	36	47	3	4	73
Orléansville,	do.	15	do.	do.	36	10	1	21	387

* The small figures in brackets show the number of observations, from ships' logs, from which the means have been deduced. For these Red Sea means, the author is indebted to the courtesy of the Meteorological Council.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
41·9	42·0	46·0	54·8	62·8	70·6	75·7	76·0	69·9	62·6	54·1	47·0	58·6	...
47·4	48·8	55·4	58·0	69·3	75·8	79·9	79·2	72·8	66·3	56·5	50·0	63·3	...
52·9	60·6	64·0	70·7	77·0	82·8	84·7	84·6	81·7	63·3	60·4	58·6	70·0	...
39·2	48·0	51·4	54·3	66·0	72·1	79·7	73·8	68·4	61·3	54·9	39·6	59·1	...
51·8	51·1	55·8	59·1	67·0	74·6	79·0	77·7	74·3	67·5	61·3	55·6	64·6	...
[159] 61·5	[198] 62·8	[269] 65·8	[202] 69·9	[231] 74·6	[212] 78·7	[250] 81·2	[166] 82·2	[187] 80·7	[214] 77·9	[245] 71·4	[219] 66·8	72·8	...
[153] 66·6	[214] 67·8	[269] 71·0	[235] 73·7	[264] 77·7	[240] 80·7	[214] 82·8	[185] 84·2	[184] 82·3	[218] 79·8	[256] 76·2	[216] 71·6	76·2	...
[151] 69·7	[199] 70·2	[234] 73·4	[210] 75·8	[231] 78·2	[216] 82·0	[208] 84·1	[161] 85·7	[174] 84·4	[214] 82·1	[267] 78·0	[209] 74·7	78·2	...
[153] 73·1	[198] 72·8	[244] 75·3	[234] 77·9	[214] 81·0	[218] 83·0	[193] 85·9	[150] 87·6	[179] 86·0	[205] 84·2	[241] 80·9	[202] 77·3	80·4	...
[149] 75·4	[197] 75·0	[257] 76·9	[244] 79·7	[203] 82·7	[224] 84·4	[208] 87·2	[151] 88·7	[171] 87·5	[202] 85·5	[265] 82·8	[233] 78·8	82·0	...
[147] 77·4	[221] 76·7	[268] 79·2	[228] 81·3	[223] 84·2	[193] 86·1	[200] 88·1	[152] 89·3	[178] 88·4	[186] 87·2	[296] 84·3	[250] 80·8	83·6	...
[150] 77·8	[232] 78·0	[397] 79·8	[336] 82·8	[239] 85·2	[185] 87·6	[201] 89·8	[145] 89·7	[195] 89·2	[203] 87·3	[246] 83·4	[242] 79·8	84·2	...
[229] 77·7	[234] 78·3	[373] 80·1	[372] 82·1	[225] 85·6	[203] 88·6	[198] 89·5	[152] 89·8	[197] 89·6	[192] 86·6	[289] 82·0	[263] 78·9	84·1	...
[134] 77·3	[189] 77·7	[243] 79·8	[220] 82·5	[205] 85·5	[175] 87·5	[166] 87·4	[120] 87·3	[167] 87·7	[165] 84·5	[222] 80·8	[252] 78·4	83·0	...
[186] 76·4	[229] 77·5	[310] 79·3	[220] 82·3	[246] 85·2	[201] 87·4	[198] 84·2	[173] 84·1	[214] 85·9	[177] 83·5	[199] 79·9	[315] 77·7	82·0	...
[156] 76·3	[181] 76·8	[269] 78·9	[186] 81·7	[214] 84·9	[175] 86·9	[178] 86·6	[139] 85·4	[194] 86·2	[197] 82·7	[197] 79·2	[249] 77·7	82·0	...
[162] 76·1	[176] 76·7	[273] 78·6	[165] 81·5	[228] 84·7	[178] 87·3	[180] 86·9	[151] 85·1	[209] 86·2	[163] 81·3	[204] 78·9	[241] 77·1	81·7	...
79·3	79·9	79·5	85·5	88·9	91·4	93·0	93·4	92·0	87·8	82·2	80·2	86·1	...
77·5	77·3	79·3	83·1	87·6	91·4	93·9	94·3	91·4	89·2	84·2	80·6	85·8	...
66·9	68·0	71·8	72·9	(69·3)	(66·0)	62·4	62·6	66·9	66·2	65·5	63·7	66·9	...
62·4	67·5	80·4	81·8	92·2	90·5	94·4	91·1	86·6	81·5	69·1	61·8	79·9	...
64·9	66·6	71·1	75·9	79·2	83·8	84·6	85·0	83·8	79·2	74·1	68·0	76·3	...
53·1	53·4	59·5	66·5	72·0	77·4	80·6	80·0	76·6	74·3	63·3	56·3	67·7	...
55·0	55·6	61·3	68·5	72·0	78·1	81·1	81·7	74·8	72·7	63·5	57·4	68·5	...
54·0	54·0	58·8	63·2	67·3	72·1	77·0	77·7	75·2	71·9	64·6	57·5	66·1	...
58·0	58·3	61·2	66·0	70·1	75·0	77·5	78·9	77·4	74·4	68·5	62·3	69·0	...
54·2	56·4	62·4	71·4	78·7	83·8	85·0	84·4	79·4	73·5	66·2	58·7	71·2	...
54·7	55·0	62·2	65·0	71·4	76·3	79·2	80·4	81·7	74·1	66·4	62·2	69·0	...
57·6	59·1	61·3	65·4	70·0	74·4	79·1	80·8	79·6	75·1	66·9	60·3	69·1	...
...	...	...	...	76·5	...	...	...	...	...	...	...	...	...
56·3	56·5	...	...	...	...	80·8	84·9	80·2	71·1	65·8	57·4	69·0	...
55·4	55·4	57·0	60·8	66·7	71·4	78·1	78·7	75·1	68·9	61·2	55·7	65·4	...
49·5	50·1	53·1	58·1	65·3	73·4	80·7	80·0	72·8	64·7	56·0	49·8	62·8	...
45·6	46·1	49·8	55·0	62·0	71·5	80·4	79·0	72·2	60·9	51·8	45·8	60·0	...
55·2	55·0	57·6	61·2	66·7	72·3	79·0	79·4	74·6	68·0	61·6	55·0	65·5	...
54·0	55·0	56·1	61·2	64·8	70·7	76·6	78·1	73·4	67·6	59·5	54·7	64·3	...
49·8	51·7	55·4	60·6	69·3	77·4	86·0	84·6	76·7	67·0	56·5	49·6	65·4	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Oran, . . .	Algeria	15	1870–84	M.T.	35 42	−0 39	173
Cape Falcon, .	do.	15	do.	do.	35 46	−0 47	257
Nemours, . .	do.	15	do.	do.	35 6	−1 51	13
Tébessa, . .	do.	15	do.	do.	35 24	8 6	2890
Aumale, . .	do.	15	do.	do.	36 10	3 41	2972
Biskra, . .	do.	15	do.	do.	34 5	5 40	409
Laghouat, . .	do.	15	do.	do.	33 48	2 51	2454
Tlemsen, . .	do.	15	do.	do.	34 53	−1 18	2703
Sidi-bel-Abbés, .	do.	15	do.	do.	35 2	−0 39	1562
Tangier, . .	Morocco	6	1879–85	7, N.: 9, 9	35 45	−5 47	200
Mogador, . .	do.	7½	1866–71, '78–79	M.m.	31 30	−9 44	54
Cape Juby, . .	Sahara	4⅔	1883–88	do.	27 58	−12 52	23
Laguna di Tenerife,	Canaries	6	1876–82	do.	28 12	−16 24	1790
Ste. Croix de la Palme,	do.	5	1880–84	do.	28 4	−17 47	113
Las Palmas, . .	do.	5	do.	do.	27 28	−17 48	30
Praya, . . .	Cape Verde Islands	5	1875–79	do.	14 54	−23 31	112
St. Nicholas, .	do.	¾	1868–69	M.T.	16 33	−24 13	2280
St. Louis, . .	Senegambia	5½	1873–78	do.	16 7	−16 30	16
Dagana, . .	do.	1	1862	6 : 2, 9	16 30	−15 31	22
Bakel, . . .	do.	1	1860–61	M.m.	14 33	−12 29	92
Bammaku, . .	do.	1	1883–84	6 : 2, 9	11 54	−7 57	940
Bafoulabé, . .	do.	2	1882–84	do.	10 0	−11 0	?
Kita, . . .	do.	2	do.	do.	13 4	−11 48	1090
Boké, . . .	do.	1⅙	1878–79	6 : 3, 10	10 54	−14 14	600
Freetown, . .	Sierra Leone	9	1875–83	M.m.	8 30	−13 9	224
Grand Bassam, .	Guinea	2	1858–59, '63	6 : 1	5 11	−3 57	0
Assinie, . .	do.	3	1847–48, '57–58, '63	do.	5 8	−3 23	0
St. George d'Elmina,	do.	3	1859–62	6 : 2, 9	5 5	−1 20	59
Christiansborg, .	do.	7½	1829–40	various	5 24	−0 10	66
Lagos, . . .	do.	1½	1886–87	M.T.	6 12	3 25	25
Akassa, . .	do.	2	1887–88	9 : 9	4 20	6 20	21
Sokna, . .	Fezzan	$\frac{1}{12}$	1865	S.R. : 3	28 55	15 44	1096
Mourzuk, . .	do.	$\frac{5}{12}$	1865–66	do.	25 54	14 12	1650
Ghadames, . .	Sahara	⅙	1865	do.	30 10	9 14	1323
Kufra, . . .	do.	⅙	1866	do.	24 30	22 0	1614
Abdezenga, . .	do.	⅙	1867	do.	8 54	6 48	1467
Schimmerdru, .	do.	⅙	1866	do.	18 57	12 10	1640
Khartum, . .	do.	2	1852, 1878	M.T.	15 36	32 36	1273
Kobbé, . .	do.	1	?	?	14 11	28 8	1800
Ankober, . .	do.	1	?	M.m.	9 35	39 20	8739
Gondokoro, . .	do.	1½	1853–54	M.T.	4 55	31 28	1526
Lado, . . .	do.	4	1880–83	do.	5 2	31 50	1526
Rubaga, . .	do.	3	1877–81	do.	−5 24	33 33	4265
Tanganika Sea, .	do.	2	1880–82	do.	−4 0	29 0	2460
Kakoma and Igonda,	do.	1	1881–82	7 : 2, 9, 9	−5 40	32 35	3675
Kavala Island, .	do.	$\frac{5}{12}$	1888	M.m.	?	?	2910
Kuka, . . .	do.	2½	1870–72	S.R. : 2, 9	12 52	13 23	920
Kano, . . .	do.	?	?	?	12 0	9 20	1758
Soccatu, . .	do.	?	?	?	13 5	6 12	639
Nango, . .	do.	1	1880–81	M.T.	13 0	11 20	960
On the Niger, .	do.	1	?	3, 9 : 3, 9	8 9	4 40	100

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
53·6	54·8	57·0	61·7	66·8	72·3	76·7	77·0	73·6	66·6	59·9	54·0	64·5	...
55·6	56·3	58·1	61·7	65·8	71·8	77·1	77·5	74·3	67·8	61·3	56·3	65·3	...
54·0	55·0	56·7	61·0	65·5	71·6	77·3	76·7	72·8	66·1	59·4	55·1	64·3	...
44·3	45·4	49·5	55·2	63·6	73·6	79·5	78·4	70·8	60·7	50·6	44·2	59·6	...
43·5	45·8	49·5	54·7	63·4	75·0	82·5	79·7	71·8	61·8	51·4	43·8	60·2	...
52·0	54·5	60·0	67·6	74·8	84·1	90·0	88·7	81·4	70·8	59·2	52·7	69·6	...
46·2	49·6	53·2	61·3	69·4	80·5	86·3	83·3	75·3	64·1	53·0	46·6	64·1	...
47·6	48·5	50·4	55·2	61·8	68·5	77·3	77·0	70·6	62·0	55·2	47·9	60·2	...
45·1	48·3	51·3	55·6	62·8	70·1	78·4	76·8	69·2	60·7	52·2	46·1	59·7	...
55·4	56·8	58·3	60·4	65·5	70·6	74·8	75·6	71·1	65·5	60·4	54·8	64·1	...
61·3	61·8	63·7	66·4	68·5	70·5	70·8	71·3	70·3	68·7	65·9	61·8	66·8	...
61·2	61·2	62·5	64·5	65·3	67·1	67·8	69·4	69·7	67·6	65·5	61·9	65·3	...
55·8	55·6	57·0	60·1	62·3	64·8	69·6	72·3	69·8	66·4	61·4	57·5	62·7	...
61·6	61·8	62·8	64·2	65·0	68·2	71·6	72·3	72·8	69·8	66·7	63·9	66·7	...
65·3	65·0	65·3	66·3	69·4	71·5	73·0	74·6	73·6	74·7	70·6	65·3	69·6	...
72·0	72·0	72·9	73·9	75·2	76·6	77·9	79·7	79·6	79·3	77·9	75·2	76·0	...
58·8	(59·0)	(60·0)	(61·5)	63·3	65·5	68·4	68·7	72·0	66·9	64·8	61·9	64·2	...
70·3	71·8	71·4	70·5	71·4	77·7	81·0	82·0	83·1	82·2	78·1	72·9	76·0	...
70·5	74·0	77·0	79·0	80·2	81·3	83·3	82·8	82·6	85·1	76·0	70·3	78·5	...
77·7	80·8	85·1	91·0	92·3	88·2	82·0	80·2	80·2	81·3	81·9	77·4	83·0	...
79·7	84·5	(85·0)	(86·0)	85·1	83·5	79·3	79·3	81·5	82·6	80·8	81·5	82·4	...
74·6	80·5	85·7	90·7	90·9	85·5	80·4	79·6	80·2	81·5	76·6	74·0	81·7	...
78·9	78·0	85·3	87·9	89·8	85·2	79·5	77·4	78·3	80·7	79·3	77·4	81·5	...
75·9	80·6	83·1	85·5	84·9	81·3	79·0	77·5	78·3	78·6	80·6	78·8	80·2	...
82·0	82·9	83·6	83·8	83·6	82·0	80·2	79·7	79·5	80·6	81·4	81·8	81·8	...
82·0	81·8	83·6	83·2	83·4	81·9	80·3	80·2	81·8	82·8	83·1	82·8	82·2	...
82·3	82·1	83·4	84·5	84·5	80·9	79·2	79·5	78·6	81·1	82·9	82·8	82·8	...
79·6	80·8	81·7	81·6	80·6	79·2	76·8	75·0	75·6	78·8	80·8	80·4	79·3	...
80·6	81·7	82·8	83·1	82·6	79·2	77·0	75·6	77·9	80·6	81·9	81·1	80·3	...
79·3	81·0	82·2	82·5	81·2	77·2	76·6	77·0	77·7	80·0	81·2	81·0	79·8	...
79·0	79·4	79·9	80·1	79·2	77·5	76·3	75·2	76·6	77·0	77·8	78·5	78·0	...
...	63·3	...	...	...	...	...	...	...	...	...	...	...	...
49·3	56·8	72·9	...	...	...	...	...	...	...	62·1	51·1	...	...
...	...	...	...	...	...	89·2	90·3	...	...	...	...	...	...
...	...	...	...	...	...	...	86·0	84·4	...	...	...	...	...
...	86·9	90·1	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	91·6	97·9	...	...	...	...	...	...	...	...
67·5	77·4	83·5	86·4	91·8	91·3	91·6	85·6	84·7	84·5	81·5	74·5	83·3	...
67·1	67·3	80·6	86·5	87·5	87·1	87·8	87·0	86·7	83·1	78·1	72·7	81·0	...
51·9	54·4	57·2	55·2	59·7	62·1	58·1	55·9	55·3	52·2	51·8	51·8	55·5	...
83·3	86·5	86·0	80·8	79·0	76·6	75·7	75·7	76·3	78·3	79·0	80·2	79·7	...
82·4	85·5	85·1	81·3	79·3	77·5	76·8	76·6	77·0	78·4	79·2	80·6	80·0	...
70·2	70·4	71·4	71·2	70·6	70·0	69·0	68·0	68·5	70·5	70·9	70·5	70·1	...
74·5	76·3	75·7	75·0	76·5	76·7	76·1	76·5	79·0	81·7	77·9	74·1	76·6	...
73·4	68·7	70·9	70·6	69·5	64·6	65·7	71·1	78·3	80·2	78·6	73·5	72·1	...
...	...	...	...	...	...	78·5	79·0	78·5	78·3	76·9	...	...	...
75·4	78·6	88·9	92·3	91·0	89·6	83·8	79·4	82·0	84·9	79·5	74·0	83·5	...
76·5	78·4	...	...	...	...	...	78·6	82·0	80·2	80·8	...	...	...
77·5	85·3	85·4	89·1	...	...	...	...	...	...	...	...	...	...
72·3	79·9	83·8	(86·0)	(86·0)	83·8	79·0	76·6	78·8	80·4	75·2	72·5	79·2	...
86·0	86·0	87·1	88·0	88·0	89·1	80·2	81·2	88·1	84·0	80·1	80·1	85·8	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude. °	Latitude. ′	Longitude. °	Longitude. ′	Height, Feet.
Fernando Po, .	Atlantic	$4\frac{1}{2}$	1859–63	M.T.	3	46	8	36	98
Ascension, . .	do.	2	1863–65	6 : 2, 10	−7	55	−14	25	53
St. Helena, . .	do.	6	1856–62	M.m.	−15	55	−5	43	40
St. Thomas, . .	do.	11	1870–82	do.	0	20	6	43	16
Lope, . . .	Lower Guinea	$\frac{1}{6}$	1875	M.T.	?		11	40	1212
Gabun, . .	do.	4	1880–85	M.m.	0	25	9	35	66
Chinchoxo, . .	do.	6	do.	7 : 2, 9, 9	−5	9	12	3	39
M'Boma, . .	do.	1	1884–85	M.T.	−5	47	13	11	80
Ponta de Lenha, .	do.	2	1883–85	do.	−5	57	12	40	30
San Salvador, .	do.	$3\frac{1}{2}$	1883–86	9 : 9, M.m.	−6	17	14	53	1860
Vivi, ...	do.	$1\frac{1}{4}$	1882–83	M.T.	−4	40	13	49	374
St. Paul de Loanda,	do.	5	1878–82	9 : 9	−8	49	13	7	194
Malange, . .	do.	1	1879–80	M.T.	−9	33	16	38	3850
Pungo Andongo, .	do.	$\frac{5}{12}$	1879	do.	−9	43	15	50	3898
Omaruru, . .	Damaraland	1	1883	7 : 1, 9, 9	−22	0	14	45	100
Walfischbay, .	do.	2	1885–87	do.	−22	56	14	26	10
Port Nolloth, .	Cape Colony	$\frac{7}{12}$	1876–77	do.	−29	15	16	52	[0]
Springbok, . .	do.	4	1882–86	8 : 8	−29	40	17	53	3200
Clan William, .	do.	10	1869-74,76,77,83,84	M.m.	−32	10	18	53	300
Sutherland, . .	do.	15	1870–84	do.	−32	24	20	40	4780
Cape Town, . .	do.	15	do.	do.	−33	56	18	27	37
Wynberg, . .	do.	15	do.	do.	−34	0	18	28	250
Somerset, West, .	do.	4	1861–64	do.	−34	5	18	52	100
Wellington, . .	do.	15	1870–84	do.	−33	38	19	0	430
Worcester, . .	do.	15	do.	do.	−33	40	19	27	780
Mossel Bay, . .	do.	15	do.	do.	−34	11	22	9	105
Cape St. Francis, .	do.	15	do.	do.	−34	10	24	50	25
Port Elizabeth, .	do.	15	do.	do.	−33	57	25	37	181
Graff-Reinet, .	do.	15	do.	do.	−32	16	24	34	2500
Nels Poort, . .	do.	15	do.	do.	−32	14	23	4	3100
Brakfontein, .	do.	15	do.	do.	−31	52	23	0	4100
Somerset, East, .	do.	15	do.	do.	−32	44	25	35	2400
Cradock, . .	do.	15	do.	do.	−32	11	25	38	2850
Graham's Town, .	do.	6	1854–59	do.	−33	20	26	33	1800
King William's Town,	do.	15	1870–84	do.	−32	51	27	22	1334
East London, .	do.	15	do.	do.	−33	2	27	55	40
Colesberg, . .	do.	15	do.	do.	−30	34	25	33	?
Aliwal, North, .	do.	15	do.	do.	−30	43	26	43	4400
Bloemfontein, .	do.	15	do.	do.	−28	56	26	19	4550
Durban, . .	Natal	5	1876–80	do.	−29	50	31	0	150
Fort Napier, .	do.	15	1870–84	do.	−29	3	30	2	2300
Pietermaritzburg, .	do.	10	1858–67	do.	−29	30	30	20	2093
Kimberley, . .	do.	15	1870–84	do.	−28	48	25	2	4060
Lorenço Marques, .	Sofala	$1\frac{3}{4}$	1876–78	8 : 8	−25	28	32	37	16
Monopolole, . .	Bechuana	4	1880–83	do.	−24	0	25	0	3750
Pretoria, . .	Transvaal	$3\frac{1}{3}$	1875–78	M.T.	−25	45	28	50	4462
Basutoland, . .	Basutoland	1	1882–83	7 : 1, 10	−29	46	27	40	5578
Tete, . . .	Zambezi	1	?	do.	−16	9	33	30	250
Zanzibar, . .	Zanzibar	11	1874–84	do.	−6	10	39	11	23
Socotra, . .	Indian Ocean	$\frac{5}{12}$	?	?	12	30	54	0	570

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
81·9	81·7	80·4	79·2	76·6	75·4	76·4	76·1	74·5	76·4	78·3	80·4	78·1	...
77·4	79·8	80·3	80·2	79·0	78·0	76·5	75·6	74·0	74·4	75·3	76·0	77·2	...
73·5	74·6	75·6	74·5	72·0	69·8	68·0	67·9	68·2	69·2	70·3	71·6	71·3	...
78·4	78·8	78·8	78·6	78·2	76·6	75·0	75·2	77·0	77·4	77·6	78·4	77·5	...
...	...	...	...	...	...	79·0	79·0	...	...	...	...	...	...
79·5	79·9	79·7	80·0	79·4	75·5	74·3	75·6	78·0	78·3	78·4	79·0	78·1	...
77·4	79·3	79·3	77·7	75·7	72·3	71·2	71·3	73·8	76·5	78·3	78·3	75·9	...
80·1	80·8	81·5	79·9	79·1	74·5	73·0	(73·0)	(75·0)	77·4	77·4	79·0	77·6	...
80·0	81·0	81·0	80·8	78·8	74·5	72·2	72·6	74·2	77·0	78·5	80·0	77·6	...
74·8	75·9	75·9	75·2	74·0	70·3	67·8	68·8	70·9	73·3	73·5	73·9	72·9	...
78·4	79·5	79·0	78·6	77·5	72·7	70·9	70·5	75·2	77·4	78·6	77·9	76·4	...
76·6	78·4	78·0	77·2	74·4	69·5	66·0	66·0	69·2	73·0	77·2	77·2	73·4	...
69·8	69·1	69·4	68·9	65·1	64·2	64·9	67·6	69·1	69·8	69·8	68·9	68·1	...
...	70·3	71·1	71·8	69·1	67·3	...	...	...	...	...	...	...	...
74·5	76·6	72·1	68·0	61·3	56·5	54·1	55·6	68·7	70·5	77·0	77·7	67·6	...
64·6	65·7	66·5	64·6	65·0	61·8	57·9	56·4	59·1	59·5	60·1	63·0	62·0	...
65·1	64·3	...	...	...	...	...	55·6	57·6	62·1	64·5	65·5	...	...
69·5	69·4	66·5	62·3	58·0	50·6	49·6	51·0	55·7	60·1	64·0	68·8	60·5	...
74·6	73·8	70·7	64·5	58·4	52·8	51·6	53·4	59·0	65·0	68·6	72·5	63·7	...
66·0	65·4	60·3	53·7	46·3	42·0	40·7	42·6	50·0	54·6	58·8	63·0	53·6	...
69·9	69·3	67·0	63·3	58·7	56·2	55·1	55·8	58·1	61·6	65·0	67·8	62·3	...
69·6	69·5	67·2	63·9	58·8	56·5	55·3	56·6	58·3	62·0	64·6	67·4	62·5	...
71·0	71·9	67·5	63·0	59·0	55·1	54·3	54·4	56·4	60·6	63·7	70·6	62·3	...
73·0	72·8	69·2	63·5	57·3	53·6	52·4	54·2	57·0	63·7	67·6	68·8	62·8	...
72·0	71·8	69·0	63·8	57·0	53·9	52·8	54·4	58·1	62·8	67·0	69·6	62·7	...
70·7	70·5	67·4	65·1	60·8	59·2	57·2	58·0	59·8	62·5	64·5	68·0	63·6	...
69·0	67·6	65·3	62·8	60·7	52·2	57·1	57·4	58·7	59·9	63·4	66·3	62·3	...
70·8	70·2	68·2	64·8	61·3	58·9	57·3	58·5	60·4	62·7	65·3	68·5	63·8	...
73·7	74·0	68·7	64·0	59·0	54·9	52·3	54·8	59·5	65·3	68·8	72·6	64·0	...
73·6	73·0	67·8	62·8	57·6	51·8	51·6	55·3	60·8	64·8	66·8	71·6	63·1	...
73·0	72·0	65·8	59·3	51·5	47·2	45·8	50·5	55·7	62·7	67·3	71·5	60·2	...
71·5	70·5	67·2	62·6	57·8	53·6	53·0	55·0	58·6	62·8	65·2	69·9	62·3	...
73·7	74·0	67·8	62·9	56·4	52·7	50·2	53·5	59·2	64·8	68·8	72·4	63·0	...
70·3	70·8	68·4	63·5	59·5	55·9	53·1	56·0	58·5	61·9	66·4	68·0	62·7	...
70·9	70·5	66·8	63·2	57·5	54·0	53·5	54·7	59·8	62·4	65·0	69·3	62·3	...
70·5	70·0	68·7	66·2	62·6	59·9	58·4	59·9	62·2	64·0	66·8	69·6	64·9	...
75·4	74·2	66·8	61·8	54·1	46·8	45·8	50·6	58·0	63·6	68·2	71·4	61·4	...
72·8	71·6	66·0	58·5	51·2	44·0	43·5	48·4	57·3	63·3	67·9	72·5	59·8	...
73·5	72·5	67·3	61·4	53·3	47·5	46·6	51·6	59·8	65·2	68·4	72·8	61·6	...
74·8	75·1	73·8	68·9	67·9	64·5	63·1	65·8	65·6	67·5	71·1	74·6	69·4	...
71·8	72·4	70·8	66·7	62·4	57·9	57·3	61·4	64·4	67·1	68·2	70·0	65·9	...
71·6	71·8	69·7	65·0	58·8	55·1	55·7	60·3	64·8	66·1	69·4	70·3	64·9	...
78·8	77·8	72·0	66·0	58·3	52·7	51·8	55·0	64·5	70·4	73·5	77·3	66·4	...
80·5	81·6	79·3	75·4	72·5	66·0	66·0	68·9	69·6	72·3	76·0	79·2	73·8	...
77·3	77·4	74·1	67·0	61·8	57·7	56·0	61·8	69·4	73·5	76·5	76·5	69·1	...
73·6	73·4	70·0	67·1	64·9	59·7	58·8	59·9	66·9	68·0	70·0	70·0	66·9	...
64·8	70·2	62·4	54·0	51·5	48·2	47·8	52·3	58·0	59·2	64·4	64·5	58·1	...
85·0	83·0	82·0	81·0	79·0	75·0	73·0	76·0	81·0	83·0	84·0	84·0	80·0	...
82·0	82·2	82·7	80·6	79·1	78·5	77·0	77·0	77·8	79·0	80·4	81·6	79·8	...
78·0	77·8	78·2	88·2	85·1	...	...	...	...	...	...	...	...	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Nosse-bé, . .	Indian Ocean	1	1879–80	6, 10: 6, 10	−13 23	48 20	80
Seychelles, . .	do.	1½	1883–84	M.m.	−4 0	57 0	8
Rodriguez, . .	do.	11	1876–86	do.	−19 48	63 10	10
St. Denis, Reunion,	do.	3	1883–85	do.	−20 50	55 15	51
R.A. Oby., Mauritius,	do.	15	1870–84	M.T.	−20 6	57 33	178
Beau Séjour, do.	do.	15	do.	do.	?	?	970
Colmar, do.	do.	15	do.	do.	?	?	800
Kerguelen, . .	do.	7/12	1840, '74–75	do.	−49 29	69 54	50
Derby, . .	West Australia	1½	1884–85	M.m.	−17 18	123 39	17
Cossack, . .	do.	4½	1881–85	do.	−20 40	117 8	19
Geraldton, . .	do.	6	1880–85	do.	−28 47	114 26	5
York, . . .	do.	6	do	do.	−31 53	116 47	580
Perth, . . .	do.	10	1876–85	do.	−31 57	115 52	47
Do. . . .	do.	6	1880–85	do.	−31 57	115 52	47
Rottnest Island, .	do.	6	do.	do.	−32 0	115 35	47
Freemantle, . .	do.	6	do.	do.	−32 3	115 45	40
Bunbury, . .	do.	6	do.	do.	−33 19	115 39	18
Albany, . .	do.	6	do.	do.	−35 2	117 54	88
Port Darwin, .	South Australia	5	1878–82	do.	−12 28	130 51	70
Daly Waters, .	do.	5	do.	9 : 9	−16 16	133 22	750
Alice Springs, .	do.	5	do.	M.m.	−23 38	133 37	2100
Port Augusta, .	do.	15	1870–84	do.	−32 29	137 45	10
Clare, . . .	do.	15	do.	do.	−33 50	138 37	1350
Eucla, . . .	do.	15	do.	do.	−31 45	128 58	7
Cape Borda, . .	do.	15	do.	three hourly	−35 45	136 35	506
Kapunda, . .	do.	15	do.	M.m.	−34 21	138 55	803
Adelaide, . .	do.	15	do.	do.	−34 57	138 35	140
Mount Barker, .	do.	15	do.	do.	−35 4	138 0	1300
Strathalbyn, .	do.	15	do.	do.	−35 16	138 55	220
Mount Gambier, .	do.	15	do.	do.	−37 50	140 50	130
C. Northumberland,	do.	15	do.	three hourly	−38 5	140 40	117
Portland, . .	Victoria	15	do.	M.T.	−38 21	141 32	37
Cape Otway, .	do.	15	do.	do.	−38 54	143 37	270
Wilson's Promontory,	do.	15	do.	do.	−39 8	146 23	300
Gabo Island, .	do.	15	do.	do.	−37 35	149 30	50
Melbourne, . .	do.	15	do.	do.	−37 50	144 50	91
Ballarat, . .	do.	15	do.	do.	−37 34	143 53	1438
Sandhurst, . .	do.	15	do.	do.	−36 43	144 21	758
Echuca, . .	do.	15	do.	do.	−36 5	144 48	314
Beechworth, .	do.	15	do.	do.	−36 17	146 42	1800
Omeo, . . .	do.	15	do.	do.	−36 58	147 46	2108
Stratford, . .	do.	15	do.	do.	−37 57	147 8	105
Eden, . . .	New South Wales	15	do.	M.m.	−37 0	149 59	107
Cape St. George, .	do.	15	do.	do.	−35 12	150 45	175
Albury, . .	do.	15	do.	do.	−36 6	147 0	572
Deniliquin, . .	do.	15	do.	do.	−35 32	145 2	320
Wentworth, . .	do.	15	do.	do.	−34 8	142 0	144
Goulburn, . .	do.	15	do.	do.	−34 45	149 45	2129
Sydney, . .	do.	15	do.	do.	−33 52	151 11	155
Windsor, . .	do.	15	do.	do.	−33 36	151 50	53

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
79·1	80·3	80·9	81·2	77·7	76·3	75·0	75·1	76·6	77·9	79·6	79·8	78·3	...
79·0	80·6	81·3	81·4	80·3	78·4	77·4	77·8	80·4	80·4	79·7	79·4	79·7	...
80·9	80·7	80·3	78·9	75·5	72·4	71·1	70·9	72·6	74·3	76·6	79·6	76·2	...
78·4	79·1	78·6	77·1	73·4	70·0	70·0	69·7	71·2	73·1	75·7	77·8	74·5	...
79·0	78·7	78·0	76·7	73·4	70·4	68·9	69·1	70·3	72·4	75·3	77·6	74·2	...
76·3	76·4	76·3	75·0	71·6	68·4	67·2	67·5	68·3	70·8	72·3	75·5	72·1	...
77·8	77·4	77·3	75·1	72·6	69·8	67·4	67·4	69·6	72·3	74·6	76·7	73·2	...
44·2	45·7	...	...	36·0	35·4	35·2	...	...	...	40·5	43·9	...	...
88·0	84·0	85·0	80·0	76·0	73·0	70·0	75·0	80·0	86·0	89·0	88·0	81·2	...
88·5	89·6	85·0	78·5	74·8	66·0	65·6	70·0	75·0	79·8	82·6	87·6	78·6	...
73·2	74·6	71·3	66·9	62·6	58·9	57·5	58·1	60·5	63·6	68·3	70·8	65·5	...
76·4	76·0	70·7	63·3	56·1	52·8	51·6	52·4	55·8	61·5	68·9	73·4	63·2	...
76·0	76·3	72·2	66·1	60·1	56·0	55·0	56·5	59·7	63·8	68·9	71·4	65·1	...
75·8	75·6	71·4	65·3	59·5	55·5	54·6	56·1	59·2	63·2	68·9	71·5	64·7	...
72·0	72·2	70·0	65·8	61·6	58·2	57·6	57·6	59·4	61·7	66·3	69·2	64·3	...
73·4	72·5	69·4	64·5	59·6	55·6	55·0	55·6	57·0	59·7	66·0	70·6	63·2	...
69·5	69·8	65·6	62·6	58·1	55·1	54·8	54·8	57·3	59·5	64·6	67·2	61·5	...
64·7	66·1	63·3	60·7	56·8	53·6	52·6	53·0	54·7	56·5	60·3	63·5	58·6	...
84·7	84·5	85·3	86·0	82·4	78·6	78·0	80·6	84·2	86·3	87·3	85·9	83·7	...
91·0	88·6	88·2	86·2	82·6	77·2	74·8	80·2	86·5	90·8	93·7	93·2	86·1	...
85·4	82·5	78·6	69·8	61·5	53·8	53·0	59·4	65·0	73·0	80·2	84·6	70·6	...
79·7	78·3	74·6	67·4	60·6	55·8	54·3	61·0	63·6	66·2	71·5	75·0	67·3	...
72·6	72·0	66·0	59·4	52·8	48·0	47·2	50·3	52·4	58·6	62·6	68·4	59·2	...
69·8	69·6	69·5	65·3	60·0	56·1	54·2	56·8	58·5	62·2	65·0	68·8	63·0	...
65·0	64·8	62·7	59·4	57·1	55·0	51·9	52·9	53·6	56·4	57·8	61·8	58·2	...
72·8	72·5	66·2	61·5	54·8	49·2	48·6	51·4	54·8	59·8	64·4	70·1	60·7	...
74·6	73·9	70·3	63·8	57·2	53·2	51·0	54·2	56·4	61·5	65·3	70·5	62·7	...
68·1	66·6	64·3	57·6	53·2	48·6	46·6	50·3	51·8	56·8	59·4	65·0	57·4	...
71·0	71·0	67·6	62·2	57·0	52·5	51·5	53·8	56·2	60·0	63·6	68·6	61·3	...
65·4	65·8	64·4	58·8	54·8	51·3	49·0	51·3	52·9	56·3	58·5	62·6	57·6	...
61·4	61·0	60·2	58·0	53·8	50·6	49·3	50·8	52·9	54·4	56·5	59·4	55·7	+1·0
63·1	63·2	62·0	59·2	53·9	51·2	49·5	51·1	52·9	55·2	57·4	60·2	56·6	...
60·7	61·5	60·5	57·1	53·7	50·8	49·2	50·6	51·3	53·0	55·5	58·0	55·2	...
62·0	63·2	62·4	59·0	54·9	51·5	49·9	50·6	52·7	54·6	56·4	59·3	56·4	...
64·6	65·5	64·7	61·2	55·9	52·2	49·8	51·8	53·7	56·7	58·9	62·0	58·1	...
65·9	66·0	63·5	58·6	53·1	49·6	47·2	50·4	53·2	56·5	59·5	63·2	57·2	...
66·7	66·5	62·6	55·5	49·8	45·6	43·5	47·2	49·9	54·4	58·1	62·6	55·2	...
72·3	71·1	66·8	58·6	52·6	47·5	46·1	49·8	52·0	57·3	62·7	67·6	58·7	...
71·6	70·6	67·0	59·2	51·6	47·0	44·7	48·5	53·0	58·7	63·5	67·7	58·6	+2·0
69·7	69·2	65·0	56·5	48·0	42·3	41·0	44·9	49·1	53·8	58·5	64·8	55·2	...
66·4	65·8	61·3	57·4	48·5	42·7	40·2	43·2	47·8	53·0	58·4	62·6	54·0	...
66·0	66·5	63·4	58·5	50·8	47·2	45·3	48·6	52·7	55·8	60·0	62·6	56·5	...
68·2	68·2	66·6	62·3	56·9	53·2	51·0	52·2	55·3	60·0	62·7	66·3	60·2	...
70·7	69·8	68·0	63·4	58·5	53·8	51·8	54·5	57·5	60·8	64·7	68·6	61·8	...
75·2	74·5	69·6	59·7	51·5	46·5	45·4	48·6	52·8	58·0	62·8	70·2	59·6	...
76·4	76·4	70·6	63·1	54·5	49·8	47·8	50·5	54·9	60·5	66·8	71·8	61·9	...
78·8	77·6	71·0	65·1	56·5	51·2	50·5	63·8	58·0	65·5	69·5	76·3	64·5	...
70·3	68·9	64·9	57·4	50·2	44·5	43·5	46·2	51·3	56·8	61·2	66·5	56·8	...
71·5	71·0	69·2	64·7	58·7	54·0	52·5	55·5	58·8	63·0	66·4	70·3	63·0	...
75·3	74·1	71·4	65·3	57·7	52·3	51·1	54·9	59·5	65·1	68·5	73·4	64·0	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Bathurst, . .	New South Wales	15	1870–84	M.m.	−33 24	149 37	2200
Newcastle, . .	do.	15	do.	do.	−32 55	151 50	112
Port Macquarie, .	do.	15	do.	do.	−31 25	152 54	53
Dubbo, . .	do.	15	do.	do.	−32 18	148 35	1200
Armidale, . .	do.	15	do.	do.	−30 34	151 46	3278
Tenterfield, . .	do.	15	do.	do.	−29 5	152 4	2800
Forbes, . .	do.	15	do.	do.	−33 27	148 5	1120
Bourke, . .	do.	15	do.	do.	−30 3	145 58	456
Narrabi, . .	do.	15	do.	do.	−30 20	149 46	460
Thergomindal, .	do.	15	do.	do.	−28 0	142 30	450
Brisbane, . .	Queensland	15	do.	do.	−27 28	153 6	130
Moreton Bay, .	do.	15	do.	do.	−27 1	153 28	320
Warwick, . .	do.	15	do.	do.	−28 12	152 16	1521
Toowoomba, .	do.	15	do.	do.	−27 34	152 10	1960
Hollow Mackay, .	do.	4	1876–79	do.	−21 10	149 11	200
Ravenswood, .	do.	$2\frac{1}{2}$	1870–73	9 : 9	−20 20	146 50	600
Somerset, Cape York,	do.	$2\frac{1}{3}$	1865–67	M.m.	−10 44	142 36	70
Sweer's Island, .	do.	$2\frac{1}{2}$	1868–71	9 : 9	−15 0	136 0	33
Mongonui, . .	New Zealand	15	1870–84	M.T.	−35 1	173 28	70
Auckland, . .	do.	15	do.	do.	−36 50	174 51	258
Taranaki, . .	do.	15	do.	do.	−39 4	174 5	42
Napier, . .	do.	15	do.	do.	−39 29	176 55	8
Wanganui, . .	do.	15	do.	do.	−39 57	175 6	80
Wellington, . .	do.	15	do.	do.	−41 16	174 47	140
Nelson, . .	do.	15	do.	do.	−41 16	173 19	34
Cape Campbell, .	do.	15	do.	do.	−41 43	174 18	7
Christchurch, .	do.	15	do.	do.	−43 32	172 39	21
Hokitika, . .	do.	15	do.	do.	−42 42	170 59	12
Dunedin, . .	do.	15	do.	do.	−45 52	170 31	500
Queenstown, .	do.	15	do.	do.	−45 2	168 39	1070
Southland, . .	do.	15	do.	do.	−46 17	168 20	79
Chatham Island, .	do.	15	do.	do.	−43 52	176 42	100
Kent's Group, .	Tasmania	5	1861–66	do.	−39 29	147 35	280
King's Island, .	do.	5	do.	do.	−39 35	144 5	135
Goose Island, .	do.	5	do.	do.	−40 18	148 5	26
Swan Island, .	do.	5	do.	do.	−40 44	148 10	104
Hobart Town, .	do.	5	do.	do.	−42 52	147 21	37
Do. .	do.	15	1870–84	do.	−42 52	147 21	37
Port Arthur, .	do.	5	1861–66	do.	−43 9	147 54	55
Swansea, . .	do.	5	do.	do.	−42 8	148 7	18
South Bruni, .	do.	5	do.	do.	−43 30	147 22	250
Auckland Island, .	do.	$\frac{5}{12}$	1874–75	M.m.	−50 30	166 5	10
Port de France, .	New Caledonia	2	1863–64	M.T.	−22 16	166 26	22
Napoleonville, .	do.	2	do.	do.	−21 30	166 0	22
Levuka, . .	Pacific	11	1875–85	8 : 2, 10	−18 13	179 3	77
Delanasau, . .	do.	5	1876–80	M.m.	−16 38	178 37	75
Apia, . . .	do.	1	1864	M.T.	−13 50	−171 44	[0]
Tahiti, . . .	do.	5	1855–60	6 : 1	−17 32	−149 34	0
Rapa, . . .	do.	$1\frac{1}{2}$	1867–69	M.T.	−27 36	−144 11	[0]
Honolulu, . .	do.	$2\frac{1}{3}$	1885–87	do.	21 18	−157 50	32

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
72·6	71·4	65·2	57·3	50·6	44·0	43·3	46·1	51·9	56·8	62·7	69·3	57·6	...
72·8	72·2	70·8	66·0	59·6	54·8	53·6	56·2	60·4	64·4	67·7	71·6	64·2	...
73·0	73·1	70·5	65·8	60·7	55·8	54·5	56·8	60·3	63·8	67·8	71·2	64·4	...
78·6	77·7	71·7	65·0	56·6	51·6	49·7	50·5	57·7	64·2	69·5	75·9	64·1	...
70·3	69·0	64·8	57·5	50·8	45·2	44·0	47·2	52·3	58·0	64·5	69·1	57·7	...
70·2	68·6	63·8	58·2	52·0	47·7	46·6	49·0	54·8	60·0	64·2	69·0	58·7	...
78·6	76·0	69·7	62·2	55·6	50·6	47·3	49·6	55·2	61·0	66·4	74·4	62·2	...
84·2	82·6	77·5	68·5	58·4	54·1	51·5	56·0	61·8	70·0	75·8	82·3	68·6	...
85·5	82·6	78·6	69·8	59·3	53·8	51·8	55·0	61·6	70·0	74·7	81·8	68·7	...
85·3	84·2	80·5	70·0	62·6	55·5	52·6	58·0	65·4	72·7	80·0	83·2	70·8	...
78·0	76·6	75·0	70·7	65·2	60·8	58·8	60·9	64·5	69·1	73·7	77·1	69·2	...
78·0	77·5	75·6	71·8	66·9	62·7	60·0	63·1	66·7	69·7	73·4	76·7	70·2	...
72·7	72·1	68·3	62·8	57·2	50·8	48·0	52·7	58·3	63·0	68·5	72·5	62·2	...
71·6	70·0	66·1	60·8	55·5	50·4	48·2	51·5	57·1	62·0	67·7	71·4	61·0	...
81·4	80·6	77·9	73·6	68·6	63·4	61·6	65·8	71·3	74·8	81·3	83·6	73·7	...
79·0	80·8	78·3	75·6	69·6	65·7	64·6	66·9	70·5	73·8	77·5	80·2	73·5	...
80·6	80·9	80·3	80·2	80·0	77·5	76·8	76·2	77·0	79·5	81·1	81·7	79·3	...
83·5	81·9	83·7	82·6	75·0	71·8	70·2	73·6	76·8	81·0	84·2	84·2	79·0	...
68·8	69·4	67·9	63·5	58·9	56·6	54·5	54·2	57·5	59·4	62·8	66·6	61·7	...
66·6	67·3	65·6	61·3	57·0	53·8	51·9	51·9	54·5	57·0	60·5	54·3	59·3	...
64·0	64·7	63·4	60·0	55·4	52·3	50·2	50·7	53·3	55·2	57·8	61·8	57·4	...
66·5	66·2	64·4	60·2	56·0	52·3	50·1	51·2	54·6	57·8	61·4	64·8	58·8	...
63·1	64·0	61·4	57·5	53·1	49·3	47·2	48·2	51·6	54·5	58·4	61·9	55·8	...
62·5	62·3	60·9	57·4	52·8	49·6	47·4	48·5	51·1	54·0	56·8	60·8	55·3	...
64 3	63·8	60·8	57·4	51·4	48·4	45·8	47·8	51·6	54·8	58·5	62·0	55·6	...
64·1	65·0	62·8	59·8	55·4	51·2	49·4	50·7	53·7	56·7	59·3	62·4	57·5	−2·0
61·7	60·9	58·5	53·0	48·4	43·8	42·5	43·8	48·6	52·7	56·4	60·8	52·6	...
60·2	60·0	58·5	55·1	50·7	47·4	44·8	46·1	49·6	52·2	54·3	58·4	53·1	...
57·7	57·3	55·4	51·5	47·3	44·0	42·5	44·1	46·8	50·8	53·3	56·3	50·6	...
59·8	59·6	56·6	51·5	44·3	40·4	37·7	39·9	46·8	49·5	53·4	58·0	49·8	−2·5
57·3	56·6	55·0	51·3	46·8	42·4	41·0	42·7	47·8	50·2	53·4	56·3	50·1	...
57·2	57·3	56·4	52·3	50·6	47·3	45·5	45·6	47·5	50·6	52·8	55·6	51·6	...
61·7	62·0	61·2	58·4	53·1	50·2	48·7	49·8	51·6	53·0	57·6	58·7	55·5	...
61·4	62·1	60·5	57·7	52·4	49·0	49·5	49·8	51·6	54·2	57·7	59·3	55·4	...
62·5	62·2	60·8	58·0	53·8	50·6	50·0	49·4	52·0	54·3	57·8	59·3	55·9	...
62·1	61·7	59·8	56·5	52·6	49·3	48·4	48·0	51·3	53·3	57·4	59·4	55·0	...
60·7	60·7	59·0	54·6	50·1	46·7	46·7	47·3	50·6	53·4	56·2	58·5	53·6	...
60·3	60·9	58·6	55·0	49·6	47·1	45·7	48·1	50·6	53·0	55·6	58·7	53·6	...
59·8	60·4	59·0	55·6	52·2	48·0	47·4	47·0	50·1	52·7	55·4	58·0	53·8	...
60·6	60·8	59·3	56·7	52·0	48·8	47·4	47·6	51·1	52·8	56·0	58·3	54·4	...
58·8	59·1	58·3	55·0	50·1	47·5	46·8	46·9	50·0	52·1	55·4	57·5	53·1	...
50·2	49·5	...	...	...	...	...	...	...	45·1	46·8	49·3	...	...
77·0	81·0	78·4	74·5	72·3	70·2	68·2	67·6	69·4	73·0	74·7	77·5	73·6	...
79·0	79·3	78·1	76·1	71·4	69·3	66·7	68·0	70·0	74·1	76·1	76·3	73·8	...
81·8	81·6	81·5	80·1	78·8	76·9	75·2	74·3	75·6	77·1	79·3	80·4	78·6	...
81·0	80·9	80·9	80·2	79·2	77·9	76·7	77·1	77·5	79·0	79·8	81·7	79·3	...
79·0	77·4	78·3	78·7	77·7	77·0	75·4	77·6	78·8	78·4	79·9	80·1	78·3	...
78·0	79·1	79·9	79·5	78·0	76·3	74·6	74·5	75·2	76·4	77·6	78·7	77·3	...
70·2	71·4	73·8	70·5	70·2	68·0	66·9	66·4	64·0	66·7	69·1	69·6	68·9	...
69·5	70·2	70·2	72·2	72·7	74·9	75·8	76·0	76·3	75·6	72·8	69·2	73·0	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Rajatea,	Pacific	1	?	thrice daily	16 40	156 12	0
Solomon Group,	do.	$\frac{2}{3}$	1882–84	M.T.	−5–12	154–163	0
Kara Sea,	Arctic	1	1882–83	hourly	70–71	64–65	0
Franz Josef's Land,	do.	2	1872–74	M.T.	77–79	54–65	0
Mosselbai,	do.	1	1872–73	do.	79 53	16 4	33
Torsden,	do.	1	1882–83	hourly	78 28	15 43	0
Wayprecht and Payer Exp.	do.	2	1872–74	M.T.	76–80	59–72	0
Kurmakuli,	do.	1	1882–83	hourly	72 23	52 42	23
Sodankylä,	do.	2	1882–84	do.	67 27	26 36	594
Bossekop,	do.	1	1882–83	do.	69 57	23 15	98
Bear Island,	do.	1	1865–66	8 : 8	74 39	18 48	0
Jan Mayen,	do.	1	1882–83	hourly	70 59	−8 28	35
Sabine Island,	do.	1	1869–70	do.	74 32	−18 49	0
Ivigtut,	Greenland	11	1874–84	M.T.	61 12	−48 11	16
Julianehaab,	do.	11	do.	do.	60 44	−45 59	26
Frederikshaab,	do.	4	1856–60	7 : 6	62 0	−49 24	[0]
Kornok,	do.	11	1874–84	do.	64 26	−51 0	10
Godthaab,	do.	11	do.	do.	64 11	−51 45	37
Sukkertoppen,	do.	11	do.	do.	65 24	−55 14	[0]
Egedesmunde,	do.	11	do.	do.	68 43	−52 44	12
Jacobshavn,	do.	11	do.	do.	69 13	−50 55	41
Upernivik,	do.	11	do.	do.	72 47	−55 53	39
Wolstenholm Sound,	Arctic	1	1849–50	4, 8, N., etc.	76 34	−68 45	0
Port Foulke,	do.	1	1860–61	hourly	78 18	−73 0	0
Van Rensseller,	do.	2	1853–55	do.	78 37	−70 53	0
Fort Conger,	do.	2	1881–83	do.	81 44	−64 45	0
The Discovery,	do.	1	1875–76	do.	81 44	−65 3	0
The Alert,	do.	1	do.	do.	82 27	−61 22	0
Port Kennedy,	do.	1	1858–59	four hourly	72 1	−94 14	0
Northumberland Sd.,	do.	1	1852–53	two hourly	76 52	−97 0	0
Dealy Island,	do.	1	do.	do.	74 56	−108 49	0
Winter Harbour, Melville Island,	do.	1	1819–20	do.	74 47	−110 48	0
Mercy Bay,	do.	$1\frac{2}{3}$	1851–53	do.	74 6	−117 55	0
Wellington Channel,	do.	1	1852–53	do.	75 37	−92 22	0
Assistance Bay,	do.	1	1850–51	3, 6, 9, N., etc.	74 40	−94 16	0
Griffith's Island,	do.	1	do.	two hourly	74 34	−95 20	0
Port Leopold,	do.	1	1848–49	do.	73 50	−90 12	0
Batty Bay,	do.	$\frac{2}{3}$	1851–52	8 : 8	73 12	−91 10	0
Walker Bay,	do.	1	do.	4, 8, N., etc.	71 35	−117 39	0
Princess Royal Island,	do.	1	1850–51	two hourly	72 47	−117 35	0
Cambridge Bay,	do.	1	1852–53	4, 8, N., etc.	69 3	−105 12	0
Port Bowen,	do.	1	1824–25	two hourly	73 13	−88 55	0
Beechy Island,	do.	2	1852–54	4, 8, N., etc.	74 43	−91 54	0
Gulf of Boothia,	do.	$2\frac{1}{2}$	1829–32	hourly	70 6	−91 45	0
Igloolik,	do.	1	1822–23	two hourly	69 21	−81 53	0
Fort Hope (Repulse Bay),	do.	2	1846–47, '53–54	M.T.	66 32	−86 56	10

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
78·7	80·6	80·9	79·4	77·7	78·4	75·7	77·8	77·5	77·9	77·6	79·2	78·5	...
...	...	...	82·9	84·5	82·6	81·9	81·9	81·9	81·9	81·5	...	(82·4)	...
−19·1	−1·8	−2·7	9·7	14·9	31·1	35·1	35·0	29·7	12·0	−1·8	−1·5	11·7	...
−11·2	−22·0	−13·6	0·9	14·3	30·5	35·2	32·6	22·6	1·3	−14·8	−20·8	4·6	...
14·2	−8·9	0·3	−0·6	17·1	31·6	36·8	35·0	25·0	10·0	17·4	6·1	15·3	...
3·6	17·1	3·9	22·6	23·9	36·7	41·4	41·4	30·4	25·9	16·5	−1·1	23·5	...
−10·3	−25·0	−17·6	−1·9	15·4	30·7	34·7	32·6	19·8	1·0	−14·7	−21·5	3·6	...
−6·7	14·6	5·1	20·4	22·8	34·3	42·3	41·9	31·4	20·2	10·4	4·4	20·3	...
8·8	16·0	18·7	28·1	39·0	54·6	55·1	50·6	41·5	32·3	20·6	9·3	31·2	...
20·2	22·9	23·5	34·5	41·8	52·8	53·3	53·7	46·7	38·1	16·4	12·8	34·7	...
4·0	16·3	6·0	13·5	23·7	33·4	(39·0)	36·8	33·1	27·3	21·8	16·5	22·4	...
18·9	24·1	13·5	27·1	24·8	35·4	38·3	37·6	35·4	35·8	28·6	14·7	27·8	...
−11·4	−11·0	−10·1	2·3	22·3	36·1	38·8	33·3	24·3	7·0	−1·1	1·2	10·9	...
18·3	17·4	23·0	33·6	40·6	46·8	49·5	47·0	41·4	34·2	27·3	23·0	33·5	...
18·5	18·3	23·0	33·5	40·0	45·6	46·7	46·8	42·6	36·2	28·2	24·4	33·7	...
15·6	17·2	21·3	30·4	37·0	42·0	44·0	42·6	38·6	30·6	27·3	20·6	30·7	+1·5
14·3	14·0	17·6	27·8	36·5	43·7	47·4	48·0	37·6	29·1	24·8	18·5	29·8	...
14·5	14·0	17·1	26·6	33·8	40·3	44·2	43·0	37·6	29·5	25·2	19·0	28·7	...
13·2	12·6	16·6	29·4	37·7	45·8	49·3	47·8	39·8	30·2	25·1	18·2	30·5	...
3·2	−1·0	5·0	20·0	30·5	40·0	44·2	42·0	35·8	26·4	21·3	14·5	23·5	...
3·6	0·0	3·8	18·7	31·6	40·5	45·5	43·0	35·4	25·2	18·7	12·0	23·2	...
−5·8	−10·3	−5·8	10·0	25·2	34·9	40·5	39·4	34·0	24·4	17·1	5·7	17·4	...
−22·3	−30·6	−15·2	−3·0	25·6	39·4	39·8	33·8	27·0	12·6	−16·3	−24·1	5·6	...
−26·0	−24·9	−22·3	−11·0	23·8	33·8	40·5	(34·1)	22·6	7·6	2·8	−12·8	5·7	...
−28·2	−26·4	−34·9	−10·3	13·4	30·1	38·2	31·8	13·4	−3·6	−22·0	−31·2	−2·5	...
−37·4	−42·7	−25·0	−12·7	15·6	32·3	36·5	34·2	14·2	−8·0	−26·7	−29·8	−3·8	...
−40·7	−35·0	−37·1	−17·3	10·0	32·5	37·2	33·3	18·5	−9·8	−18·4	−24·5	−4·2	...
−33·0	−38·0	−39·8	−18·0	11·1	32·4	38·3	32·7	15·6	−5·1	−16·8	−22·2	−3·6	...
−34·7	−37·3	−18·3	−3·5	14·7	35·3	40·1	38·0	25·7	6·6	−11·9	−34·0	1·7	...
−38·6	−28·2	−17·5	−9·2	15·0	31·9	36·7	34·2	18·5	−1·3	−4·8	−30·1	0·6	...
−37·1	−31·5	−20·4	−4·3	14·8	33·4	35·7	34·8	(19·0)	(−1·0)	−10·2	−26·0	0·6	...
−31·3	−32·5	−18·2	−8·2	16·8	36·2	42·4	32·6	22·5	−2·8	−20·9	−21·6	1·3	...
−35·6	−32·2	−27·0	−2·7	12·7	31·4	36·7	33·2	20·1	−1·2	−15·5	−23·1	−0·3	...
−17·6	−22·4	−19·5	3·2	12·5	30·4	38·1	36·0	17·1	9·6	−7·5	−13·4	5·5	...
−29·0	−30·2	−22·1	−3·3	12·3	34·6	37·9	35·5	21·4	1·5	−6·8	−21·5	2·5	...
−31·0	−32·5	−25·6	−7·0	9·3	32·2	36·5	35·0	15·7	−0·6	−7·5	−23·0	0·1	...
−31·7	−31·0	−19·9	−5·3	18·1	32·3	36·2	33·4	24·0	12·0	−11·1	−32·4	2·1	...
−20·9	−19·2	−18·0	2·2	...	...	...	...	22·6	8·5	−5·9	−16·5	...	...
−18·1	−16·3	−22·6	9·9	16·0	32·5	41·3	37·1	30·2	14·1	−5·0	−16·9	8·5	...
−32·4	−37·7	−28·8	−4·8	18·9	36·1	37·5	37·5	24·6	0·2	−10·2	−23·4	1·5	...
−36·2	−29·3	−17·0	−2·9	17·1	32·5	39·8	38·5	20·1	4·4	−7·2	−29·9	2·5	...
−28·9	−27·3	−28·4	−6·5	17·6	36·1	38·9	35·8	25·9	10·8	−5·0	−19·0	4·2	...
−33·5	−25·8	−18·2	1·3	18·2	34·8	39·0	35·2	20·4	6·2	−9·3	−24·1	3·8	...
−25·8	−31·2	−28·3	−1·9	15·8	34·3	41·3	38·5	26·9	9·4	−6·0	−22·2	4·2	...
−16·1	−19·6	−19·0	−0·8	25·1	32·2	39·1	33·9	25·1	13·7	−18·6	−28·2	5·7	...
−29·6	−31·6	−23·1	−2·2	18·9	33·4	41·0	(35·0)	25·3	11·2	−9·0	−25·4	3·7	...

Stations.	Country.	No of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Hudson's Strait, .	Arctic	1	1836–37	two hourly	various	various	0
Kingawa, . .	do.	1	1882–83	hourly	66 36	−67 14	53
Ananito, . .	do.	1	1877–78	M.T.	66 20	−66 56	0
Winter Island, .	do.	1	1821–22	two hourly	66 11	−83 10	0
Fort Chimo, .	do.	2	1882–84	M.T.	59 0	−68 0	126
Fort York, . .	do.	10	1875–84	do.	57 2	−92 20	55
Fort Simpson, .	do.	2	1849–51	do.	62 7	−121 33	1830
Camden Bay, .	do.	1	1853–54	4, 8, N., etc.	70 8	−145 29	0
Fort Franklin, .	do.	$1\frac{3}{4}$	?	do.	65 12	−123 13	500
Fort Confidence, .	do.	2	1837–39	M.T.	66 40	−119 0	500
Do. .	do.	$\frac{3}{4}$	1850–51	9 : 9	66 40	−119 0	500
The above 2 stations,	do.	$2\frac{3}{4}$	1837–39, '50–51	M.T.	66 40	−119 0	500
Fort Yukon, . .	do.	1	?	do.	66 34	−145 18	412
Nulato, . .	do.	1	1843, 66–67	do.	60 40	−158 13	100
Pt. Barrow, . .	do.	2	1852–54	24 obs.	71 21	−156 16	10
Ooglaamie, . .	do.	2	1881–83	do.	71 23	−156 40	17
The above 2 stations,	do.	4	1852–54, '81–83	do.	71 22	−156 28	14
Choris Peninsula, .	do.	1	1849–50	do.	66 58	−165 17	10
Port Clarence, .	do.	2	1850–52	do.	65 17	−166 20	10
St. Michael's, .	do.	14	1872–86	M.T.	63 48	−161 0	30
Ikogmut, . .	do.	$2\frac{1}{2}$	1843, '48–50, '53–4	do.	61 47	−161 14	75
Möllen Island, .	do.	$\frac{1}{3}$	1877–78	do.	66 1	−160 47	12
St. Paul's Island, Bering Sea, .	do.	6	1869–76	do.	57 7	−170 18	57
Iliulink Harbour, .	do.	9	1827–34, '67, '71–73	do.	53 52	−166 31	15
Unalaska, . .	do.	3	1883–86	do.	53 52	−166 31	13
St. Paul, Kadiak Island, . .	do.	$2\frac{2}{3}$	1869–70, '72–73	do.	57 47	−152 20	25
Cook's Inlet, .	do.	$\frac{1}{6}$	1870	7 : 2, 9, 9	60 32	−151 19	80
Sitka, . . .	do.	43	1832–45, '47–76	M.T.	57 3	−135 19	15
Fort Wrangel, .	do.	5	1868–70, '75–77	do.	56 17	−132 29	55
Fort Tongass, .	do.	$2\frac{1}{2}$	1868–70	7 : 2, 9, 9	54 46	−130 30	25
Fort Simpson, .	Dom. of Canada	$2\frac{1}{2}$	1886–89	M.T.	54 37	−130 23	[0]
Ladner's Landing,	do.	$2\frac{1}{2}$	1879–81	M.m.	45 50	−120– 0	350
Vancouver Island,*	do.	...	...	...	...	...	0
Victoria, . .	do.	8	1881–88	7 : 2, 9, 9	48 25	−123 23	83
New Westminster,	do.	6	1874–80	do.	49 13	−122 53	54
Fort Moody, .	do.	8	1881–88	do.	49 11	−123 0	[0]
Esquimault, . .	do.	$5\frac{1}{2}$	1874–79	do.	48 26	−123 27	42
Quamichan, . .	do.	8	1881–88	M.T.	48 46	−123 24	[0]
Lillooet, . .	do.	4	1880–83	M.m.	50 42	−122 2	650
Soda Creek, . .	do.	$3\frac{1}{2}$	1882–85	7 : 2, 9, 9	52 20	−122 19	1430
Spence's Bridge, .	do.	9	1872–79, '83–84	do.	50 25	−121 30	760
Stuart's Lodge, .	do.	$1\frac{1}{4}$	1878–79	do.	54 11	−124 4	1800
Chipewyan, . .	do.	2	1884–85	do.	58 43	−111 19	700
Calgary, . .	do.	4	various	do.	50 55	−114 4	3550
Fort Dunvegan, .	do.	4	1880–84	do.	56 0	−119 0	1800
Fort Edmonton, .	do.	$4\frac{1}{2}$	1880–85	do.	53 14	−113 38	2388
Battleford, . .	do.	3	1876–78, '81–82	do.	52 41	−108 30	1615

* Off the coast.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
—18·2	—25·0	—10·4	14·2	28·8	35·0	37·5	31·6	26·9	16·1	—4·3	—22·7	9·1	...
—22·5	—32·0	—6·7	4·2	30·1	36·3	42·8	45.4	32·5	12·2	—0·8	—7·2	11·2	...
—17·7	—17·1	—12·6	11·1	26·2	35·2	42·1	39·6	36·2	29·0	7·3	—12·3	13·9	...
—23·2	—24·0	—10·7	6·5	23·3	33·2	36·0	36·9	31·6	13·2	7·9	—14·2	9·9	...
—17·8	—17·7	—8·0	15·5	35·5	42·2	55·4	47·7	40·4	29·2	15·9	—13·3	18·8	...
—22·6	—19·3	—9·7	13·8	35·0	52·5	59·2	53·2	43·0	21·4	4·1	—13·6	18·1	...
—26·0	—8·3	1·5	26·4	45·8	60·0	...	...	...	24·6	9·6	—12·0	...	...
—15·2	—30·6	—18·8	—1·2	22·4	32·4	37·7	36·0	20·4	—0·8	—9·5	—24·9	4·0	...
—22·3	—16·7	—5·4	12·3	35·2	48·0	52·1	50·6	41·0	22·4	—0·2	—10·9	17·2	...
—29·3	—19·2	—18·3	9·0	27·6	47·8	54·8	48·4	36·0	20·5	—0·9	—14·8	13·4	...
—32·3	—37·5	—18·2	7·5	25·9	42·1	...	...	...	13·7	5·8	—21·4	...	...
—30·3	—25·3	—18·3	8·4	27·1	45·9	54·8	48·4	36·0	18·1	1·3	—17·0	12·4	...
—26·8	—26·4	—11·2	12·7	41·2	53·5	65·8	59·9	38·7	21·6	—8·3	—18·4	16·8	...
—21·0	—7·5	18·0	24·2	41·7	64·2	...	...	...	...	...	—10·7	...	...
—18·7	—22·5	—14·7	1·1	20·1	32·3	36·5	38·4	26·0	2·2	—8·5	—18·2	6·9	...
—16·3	—14·8	—9·0	0·8	22·6	33·4	39·7	37·5	31·6	14·2	—3·6	—17·6	9·8	...
—17·5	—18·6	—11·8	1·0	21·4	32·8	38·1	38·0	28·8	8·2	—6·0	—17·8	8·4	...
—12·0	—15·5	—6·0	14·5	30·0	(43·0)	(47·5)	45·0	42·8	25·0	1·2	5·2	19·2	...
—11·2	0·7	4·5	11·5	32·8	40·5	49·8	45·7	40·7	22·6	0·7	0·3	19·9	...
5·2	0·0	7·0	20·2	34·6	45·6	53·8	52·4	44·0	31·0	18·0	7·8	26·6	...
1·6	—5·8	2·5	24·0	33·8	48·3	51·0	47·6	44·4	27·4	12·6	5·4	24·4	...
25·2	16·7	25·5	...	...	...	...	...	...	...	...	22·7	...	...
28·2	24·4	23·3	29·0	34·6	41·9	45·7	47·2	45·0	38·4	34·1	28·6	35·0	...
29·3	31·2	31·9	36·3	41·2	46·5	50·2	51·0	44·7	37·4	33·1	30·0	38·5	...
33·8	31·2	33·0	35·2	41·2	45·8	49·7	50·8	46·0	41·0	34·9	32·5	39·6	...
28·7	28·0	30·2	38·2	43·3	50·3	56·5	56·6	51·7	43·3	37·7	33·0	41·5	...
...	...	...	...	...	...	58·1	58·8	...	...	...	...	...	...
31·4	32·9	35·6	40·8	47·0	52·4	55·5	55·9	51·5	44·9	38·1	33·3	43·3	...
26·3	30·6	31·6	42·1	48·2	55·0	58·1	56·4	51·9	45·9	39·4	32·1	43·1	...
33·9	36·0	38·4	44·4	49·9	56·1	58·3	58·6	52·9	48·4	40·9	38·0	46·3	...
31·7	32·9	39·6	43·4	48·3	52·4	55·0	56·0	53·2	47·0	39·8	37·8	44·8	...
32·4	35·7	42·0	47·1	52·1	58·3	59·6	58·9	54·7	47·2	38·7	32·8	46·6	...
39·9	39·9	42·6	47·7	52·2	57·6	59·4	59·4	55·8	49·6	42·8	39·4	48·7	...
36·4	37·4	43·5	47·4	52·5	56·4	58·5	58·4	54·5	48·1	43·5	40·3	48·1	...
33·9	35·9	42·1	47·4	52·8	57·9	60·9	60·4	54·9	47·0	39·8	36·2	47·4	...
32·4	35·5	42·0	48·0	55·8	60·3	63·3	64·0	56·5	48·5	40·8	36·0	47·8	...
37·5	40·7	43·0	48·1	52·3	56·6	59·6	58·3	53·6	49·0	44·4	41·8	48·7	...
33·1	33·6	42·1	45·8	55·3	59·6	63·8	62·0	54·8	48·0	40·3	37·5	48·0	...
21·5	24·6	38·2	46·3	55·6	63·0	68·3	66·4	56·6	45·1	32·7	26·3	45·4	...
12·4	11·3	32·4	43·0	54·1	61·5	70·8	66·8	50·6	41·0	32·8	21·0	41·4	...
20·1	21·4	39·5	51·4	59·6	65·5	70·7	69·8	59·8	49·1	31·2	28·1	47·7	...
12·7	11·5	28·0	38·0	49·3	53·2	57·3	58·2	47·1	33·5	30·8	18·2	36·5	...
—15·5	—9 6	5·3	26·3	42·5	56·3	60·6	55·9	45·6	29·4	19·4	-3·7	27·1	...
4·4	19·4	25·8	38·8	48·8	55·6	59·4	58·0	48·2	39·7	29·3	8·7	34·5	...
—12·0	2·6	15·2	35·6	50·1	56·0	60·5	57·3	45·7	31·6	16·5	—4·6	31·2	...
1·6	5·5	24·5	38·8	49·8	57·3	59·5	58·4	48·0	36·2	20·7	5·9	33·6	...
—1·3	11·3	21·0	38·6	51·0	59·1	65·0	62·8	49·9	34·6	22·0	7·2	34·2	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Medicine Hat, .	Dom. of Canada	$5\frac{1}{2}$	1883–88	7 : 2, 9, 9	50 1	−110 37	2136
Fort M'Leod, .	do.	$4\frac{1}{2}$	1875–79	do.	49 39	−113 12	2400
Qu'Appelle, . .	do.	$5\frac{1}{2}$	1883–88	do.	50 44	−103 42	2115
Swan R. Barracks,	do.	2	1875–77	do.	51 52	−101 57	2160
Minnedosa, . .	do.	7	1881–88	M.m.	50 13	−99 48	1796
Fort Rae, . .	do.	1	1882–83	hourly	62 39	−115 44	530
Do. . .	do.	$2\frac{1}{2}$	1875–77, '82–83	M.T.	62 39	−115 44	530
Norway House, .	do.	7	?	M.m.	54 0	−98 0	700
Stony Mountain, .	do.	10	1879–88	7 : 2, 9, 9	50 22	−91 40	740
St. Andrews, .	do.	4	1882–85	do.	50 5	−97 0	1300
Winnipeg, . .	do.	14	1871–84	three hourly	49 55	−97 7	740
Gimli, . . .	do.	3	1877–80	7 : 2, 9, 9	50 37	−96 58	730
Rockwood, . .	do.	5	1878–82	do.	50 5	−97 12	?
Poplar Heights, .	do.	5	do.	do.	50 4	−97 47	?
Fort Churchill, .	do.	$3\frac{1}{2}$	1811–13, '84–85	M.T.	58 44	−94 22	20
York Factory, .	do.	10	1875–84	do.	57 0	−92 28	55
Albany, . .	do.	3	1878–81	do.	52 32	−94 4	1300
Martin Falls, .	do.	3	do.	do.	51 30	−86 30	1000
Moose Factory, .	do.	24	1857–80	do.	51 15	−80 45	33
Rama, . . .	do.	$3\frac{1}{3}$	1882–85	8 : 8	58 53	−62 21	49
Hebron, . .	do.	$3\frac{1}{3}$	do.	do.	58 12	−63 15	11
Okak, . . .	do.	$3\frac{1}{3}$	do.	do.	57 34	−61 56	25
Nain, . . .	do.	$3\frac{1}{3}$	do.	do.	56 33	−61 41	14
Zoar, . . .	do.	$3\frac{1}{3}$	do.	do.	56 7	−61 22	31
Hoffenthal, . .	do.	$3\frac{1}{3}$	do.	do.	55 27	−60 12	25
Fort Churchill, .	do.	$1\frac{1}{3}$	1884–85	3, 7, 11 : 3, 7, 11	58 43	−94 10	20
Port Laperrierre, .	do.	$1\frac{1}{3}$	do.	do.	62 34	−78 1	250
P. de Boucherville,	do.	$1\frac{1}{3}$	do.	do.	63 12	−77 28	120
Asher's Inlet, .	do.	$1\frac{1}{3}$	do.	do.	62 33	−70 35	250
Stupart's Bay, .	do.	$1\frac{1}{3}$	do.	do.	61 35	−71 32	350
P. Burwell, . .	do.	$1\frac{1}{3}$	do.	do.	60 22	−64 46	27
Skinner's Cove, .	do.	$1\frac{1}{3}$	do.	do.	59 6	−63 37	90
Bellisle, . .	do.	$2\frac{1}{3}$	1882–84	$2\frac{1}{2}$, $8\frac{1}{2}$: $4\frac{1}{2}$	51 53	−55 22	405
St. John's, N.F., .	do.	15	1870–84	7 : 2, 9, 9	47 34	−52 42	150
Fogo, . . .	do.	15	do.	do.	49 44	−54 11	28
Channel, . .	do.	15	do.	8 : 2, 9	47 34	−59 7	30
Bay St. George, .	do.	15	do.	7 : 2, 9, 9	48 26	−58 30	8
Harbour Grace, .	do.	15	do.	do.	47 22	−55 25	[0]
Sydney, . .	do.	15	do.	three hourly	46 8	−60 10	28
Truro, . . .	do.	15	do.	7 : 2, 9, 9	45 22	−63 18	77
Windsor, . .	do.	15	do.	do.	44 59	−64 6	87
Digby, . . .	do.	15	do.	do.	44 38	−66 46	150
Charlottetown, .	do.	15	do.	*	46 14	−63 10	38
Kilmahumaig, .	do.	15	do.	7 : 2, 9, 9	46 48	−64 2	20
Halifax, . .	do.	15	do.	three hourly	44 39	−63 36	122
Yarmouth, . .	do.	15	do.	*	43 50	−66 2	61
St. John's, N.B. .	do.	15	do.	two hourly	45 17	−66 3	150
Fredericton, .	do.	15	do.	three hourly	45 57	−66 38	59
Chatham, . .	do.	15	do.	*	47 3	−65 29	56
Bathurst, . .	do.	15	do.	7 : 2, 9, 9	47 39	−65 42	9
Dalhousie, . .	do.	15	do.	do.	48 4	−66 22	150
Bird Rocks, . .	do.	15	do.	do.	47 51	−61 8	85

* At 6.50 : 2.50, 10.50 Toronto Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
1·4	11·9	28·8	44·0	56·2	63·6	68·3	65·3	54·6	42·6	29·4	14·6	40·0	...
14·4	23·5	28·8	42·6	53·7	61·0	67·4	64·7	55·0	43·0	32·0	26·6	42·6	...
—10·2	—2·6	12·6	36·1	50·8	60·6	62·6	59·2	50·0	37·0	20·4	2·3	31·6	...
—10·5	—13·8	2·6	33·4	51·6	55·3	62·1	61·4	50·5	38·4	—0·2	—0·7	27·5	...
—11·0	—3·6	9·4	33·0	48·6	59·0	62·2	58·5	48·6	35·1	18·0	2·5	30·2	...
—26·8	—10·4	—7·7	19·3	37·2	51·5	61·1	56·5	44·4	32·6	9·3	—15·1	21·2	...
—23·0	—21·4	—16·4	11·4	37·5	52·3	62·9	56·5	44·4	27·8	—2·7	—23·0	17·1	...
—7·2	—2·4	6·9	27·4	44·6	55·0	63·5	61·2	46·5	31·1	12·2	—1·8	29·8	...
—7·3	—0·2	13·2	35·8	50·3	62·2	66·0	64·2	51·0	38·1	20·0	0·2	32·8	...
—13·2	—8·8	6·7	34·0	49·3	60·8	62·4	61·2	51·9	39·5	19·3	—2·3	30·1	...
—5·2	0·7	11·6	33·8	52·4	62·0	66·1	64·1	51·7	38·3	16·7	0·4	32·7	...
—3·6	2·8	9·1	31·1	49·6	59·9	64·0	61·8	50·4	38·6	20·9	3·1	32·3	...
—1·5	3·3	17·3	35·8	52·3	62·8	67·6	65·4	52·6	38·4	19·0	1·6	34·6	...
—1·0	4·3	15·5	34·3	52·6	62·8	67·5	64·8	52·4	38·4	18·4	1·0	34·2	...
—26·9	—23·4	—7·8	6·2	27·1	38·8	51·0	51·5	40·8	20·5	4·2	—11·3	14·2	...
—22·0	—16·5	—7·8	16·8	35·5	53·0	61·3	53·2	42·3	27·4	6·6	—13·4	19·7	...
—7·7	—8·9	7·1	19·4	38·0	50·6	59·0	(55·2)	(48·0)	38·1	16·8	—2·1	26·0	...
—7·7	—7·5	7·4	23·7	43·9	54·0	60·3	57·4	47·6	37·7	15·8	—5·4	27·2	...
—4·5	—1·8	11·0	25·0	41·2	52·2	60·1	58·0	48·6	38·8	21·4	0·5	29·1	...
—9·8	—7·4	—1·6	19·2	33·2	40·6	46·9	45·0	38·8	30·0	19·3	1·6	21·3	...
—10·0	—8·0	—1·6	18·7	32·3	41·0	46·3	44·8	38·8	29·1	18·7	0·8	21·7	...
—11·4	—8·0	—1·1	19·4	32·6	41·8	47·5	46·7	40·0	29·6	17·8	—0·4	21·2	...
—11·2	—7·8	0·0	20·6	32·4	42·3	47·8	46·9	40·8	30·2	18·6	—0·3	21·7	...
—13·0	—7·6	0·0	21·0	34·0	43·5	50·0	48·0	41·0	31·4	17·8	—1·9	22·0	...
—10·1	—4·5	3·0	23·0	34·5	43·9	51·3	49·2	42·3	32·6	20·4	2·5	24·0	...
—24·8	—16·5	—14·3	9·0	22·5	40·5	56·0	49·8	38·4	24·1	10·8	—12·4	15·2	...
—27·4	—6·0	—19·2	6·1	23·8	35·2	40·2	39·6	32·8	22·5	11·0	—9·8	12·4	...
—26·3	—5·4	—18·7	6·7	24·7	33·1	39·1	37·7	31·7	19·5	9·8	—11·1	11·7	...
—19·2	1·6	—12·6	10·4	26·7	33·8	40·2	39·2	32·6	22·9	11·4	—5·6	15·2	...
—22·6	—3·9	—15·5	9·1	25·2	33·9	42·6	42·7	32·7	22·5	10·3	—7·4	14·1	...
—17·7	2·3	—7·3	16·2	28·0	33·4	41·9	41·7	34·2	28·2	16·2	—2·0	17·7	...
—10·6	0·9	—2·8	19·2	31·1	38·7	46·2	46·0	36·6	28·2	18·0	1·0	21·0	...
6·4	17·8	15·7	28·0	34·1	40·5	52·5	54·5	45·4	35·7	25·9	11·5	30·7	...
23·8	23·6	27·5	34·6	43·7	52·8	59·7	60·5	54·4	45·4	36·5	28·4	40·9	...
18·6	16·3	23·5	33·0	41·8	53·4	59·7	61·3	54·6	44·4	33·2	25·3	38·7	—2·0
20·4	19·6	26·2	32·0	40·5	48·6	56·2	58·8	54·4	45·5	34·2	27·7	38·5	+2·0
19·4	19·0	24·6	35·1	43·8	53·3	61·4	61·6	55·0	46·0	36·1	26·3	40·1	...
22·6	21·9	26·6	35·0	43·0	52·5	59·6	59·6	54·4	45·8	36·3	28·2	40·4	...
20·5	20·3	25·8	34·0	44·4	55·0	61·6	62·8	55·8	46·8	36·5	27·2	40·9	...
18·0	19·6	26·4	38·8	48·7	58·4	63·4	63·1	55·8	46·3	34·4	23·0	41·3	...
21·3	22·2	28·9	38·5	49·4	58·8	65·0	63·2	57·0	47·5	35·0	25·8	42·7	...
23·8	24·6	30·0	39·0	49·0	57·6	63·3	62·8	57·3	48·4	37·2	27·9	43·4	...
16·3	17·7	25·0	34·9	46·3	57·6	64·1	64·7	57·7	47·0	34·4	23·0	40·7	...
14·4	16·0	23·5	34·0	45·2	57·8	63·8	63·5	57·2	45·9	33·2	21·0	39·6	...
22·1	23·1	28·8	37·4	47·4	57·1	63·0	63·8	57·4	47·8	36·5	26·5	42·6	...
26·0	26·6	31·0	38·8	47·7	55·2	59·7	60·5	55·7	48·5	38·9	30·6	43·3	...
18·5	20·5	27·5	37·0	46·0	55·0	59·9	60·3	55·2	46·3	34·9	23·5	40·4	...
11·4	16·4	24·5	37·3	49·7	60·6	65·7	64·4	56·2	44·4	31·6	17·3	40·0	...
10·7	15·3	22·4	36·1	48·0	59·3	64·8	64·2	55·5	43·7	31·1	16·3	39·8	...
10·6	14·8	23·4	35·7	47·0	60·6	65·9	64·8	56·8	44·4	31·1	17·5	39·4	...
5·8	10·2	19·4	32·2	44·9	57·5	63·2	62·0	52·8	39·6	27·8	15·0	35·9	...
18·2	17·5	23·0	32·0	39·3	48·7	57·1	61·3	56·4	46·1	35·3	24·6	38·3	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
Anticosti, S.-W. Pt.	Dom. of Canada	15	1870–84	7 : 2, 9, 9	49	24	−63	16	20
Anticosti, W. Pt. .	do.	15	do.	do.	49	52	−64	30	[0]
Bellisle, . .	do.	4	1877–78, '83–85	do.	51	53	−55	22	405
Point Rich, . .	do.	15	1870–84	do.	50	38	−57	20	[0]
Father Point, .	do.	15	do.	*	48	31	−68	28	20
Cape Magdalen, .	do.	5	1882–88	7 : 2, 9, 9	49	14	−65	15	[0]
Point Lewis, .	do.	15	1870–84	do.	46	48	−71	11	300
Quebec, . .	do.	15	do.	*	46	48	−71	12	312
Montreal, . .	do.	15	do.	three hourly	45	31	−73	33	187
Sherbrooke, . .	do.	15	do.	7 : 2, 9, 9	45	25	−71	57	270
Cranbourne, . .	do.	15	do.	do.	46	22	−70	37	?
Huntingdon, .	do.	15	do.	do.	45	5	−74	10	400
Chicoutimi, . .	do.	15	do.	do.	48	25	−71	5	159
Cornwall, . .	do.	15	do.	7 : 1, 9	45	1	−74	43	176
Kingston, . .	do.	15	do.	M.T.	44	14	−76	29	307
Fitz Roy Harbour,	do.	15	do.	7 : 2, 9, 9	45	30	−76	10	200
Pembroke, . .	do.	15	do.	7 : 1, 9	45	50	−77	7	389
Rockliffe, . .	do.	15	do.	*	46	12	−77	55	418
Simcoe, . .	do.	15	do.	7 : 1, 9	42	50	−80	21	700
Toronto, . .	do.	15	do.	M.T.	43	29	−79	23	350
Hamilton, . .	do.	15	do.	7 : 1, 9	43	16	−79	53	332
Port Stanley, .	do.	15	do.	*	42	40	−81	13	592
Windsor, . .	do.	15	do.	7 : 1, 9	42	19	−83	2	604
Port Dover, . .	do.	15	do.	*	42	47	−80	13	635
Woodstock, . .	do.	15	do.	7 : 2, 9, 9	43	8	−80	47	980
Stratford, . .	do.	15	do.	7 : 1, 9	43	23	−81	0	1182
Goderich, . .	do.	15	do.	do.	43	45	−81	43	728
Point Clark, .	do.	15	do.	do.	44	4	−81	51	?
Kincardine, . .	do.	15	do.	7 : 2, 9, 9	44	11	−81	37	684
Saugeen, . .	do.	15	do.	*	44	30	−81	21	656
Parry Sound, .	do.	15	do.	*	45	19	−80	0	641
Gravenhurst, .	do.	15	do.	7 : 2, 9, 9	44	54	−79	20	700
Little Current, .	do.	15	do.	do.	45	57	−81	54	608
Port Arthur, .	do.	15	do.	7 : 2, 10	48	27	−89	12	642
Savanne, . .	do.	4	1885–89	7 : 2, 9, 9	49	48	−90	4	750
Nepigon, . .	do.	2	1886–88	do.	50	0	−88	40	750
White River, .	do.	2½	1886–89	do.	46	0	−91	0	?
Eastport, . .	Maine	15	1870–84	7 : 3, 11†	44	54	−66	59	61
Portland, . .	do.	15	do.	do.	43	39	−70	15	45
Mt. Washington, .	New Hampshire	13	1872–84	do.	44	16	−71	18	6279
Burlington, . .	Vermont	15	1870–84	do.	44	29	−73	13	268
Boston, . .	Massachusetts	15	do.	do.	42	21	−71	4	142
Springfield, . .	do.	15	do.	do.	42	6	−72	36	120
Thatcher's Island, .	do.	15	do.	do.	42	36	−70	38	48
Wood's Hole, .	do.	15	do.	do.	41	33	−70	40	34
Newport, . .	Rhode Island	15	do.	do.	41	29	−71	19	44
New Haven, . .	Connecticut	15	do.	do.	41	17	−72	57	104
New London, .	do.	15	do.	do.	41	21	−72	5	47
Albany, . .	New York	15	do.	do.	42	39	−73	45	75
Buffalo, . .	do.	15	do.	do.	42	53	−78	53	696

* At 6.50 : 2.50, 10.50 Toronto Time.

† Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	
11·7	12·7	20·7	32·4	40·4	50·1	57·2	58·0	51·4	41·0	30·0	19·1	35·4	...
10·5	11·8	20·2	32·7	41·0	51·8	58·5	58·8	51·6	41·0	29·1	17·5	35·4	...
4·9	9·0	15·5	28·8	33·6	42·6	48·8	50·9	45·8	34·8	25·8	13·0	29·4	...
11·8	12·0	28·8	30·8	38·6	47·3	54·9	57·5	52·5	42·0	30·7	21·3	32·6	...
8·5	12·5	20·0	32·2	41·5	52·4	56·8	55·6	49·2	39·6	28·3	13·8	34·2	...
7·8	11·8	19·4	32·7	42·8	55·0	59·2	(53·6)	49·1	40·0	29·9	17·5	34·9	...
10·0	11·8	18·9	33·4	47·6	60·0	66·2	65·0	56·2	44·1	29·3	15·0	38·1	...
9·1	13·5	21·6	35·3	49·5	61·8	66·5	64·7	56·3	43·7	28·4	14·5	38·7	...
13·4	17·5	25·5	40·4	55·4	65·6	69·8	68·7	59·8	46·9	31·7	18·6	42·8	...
9·6	15·5	23·0	36·7	49·6	62·0	66·8	64·3	56·2	43·9	29·0	16·2	39·4	...
8·2	11·6	20·0	34·1	45·2	59·5	62·4	61·3	52·6	39·4	25·4	13·0	36·1	...
11·7	15·8	24·5	39·7	54·0	64·1	68·0	66·6	57·9	46·0	30·4	18·2	41·4	...
3·4	10·5	19·5	34·4	48·8	60·4	65·2	63·7	53·3	40·6	27·2	8·5	36·3	...
13·3	16·8	24·5	40·6	55·1	65·4	69·2	68·0	59·0	46·8	31·8	19·0	42·5	...
17·3	19·6	27·4	40·5	53·5	64·1	68·7	69·2	61·4	48·7	33·8	23·0	44·0	...
10·2	14·1	25·6	41·0	55·1	65·7	70·0	67·8	58·3	45·7	29·3	15·6	41·5	...
10·4	14·0	22·8	38·8	53·8	64·8	68·3	67·0	57·0	44·9	29·6	16·2	40·6	...
9·2	12·8	20·2	35·7	51·2	61·0	65·6	63·9	54·8	43·3	30·0	14·3	38·5	...
21·1	23·2	29·2	42·3	55·6	65·5	70·2	68·6	60·4	49·8	34·7	26·7	45·6	...
21·6	22·6	27·9	40·5	53·2	63·1	68·2	67·4	59·7	47·6	33·4	25·6	43·8	...
23·3	25·0	30·0	42·7	56·1	66·3	71·9	70·7	61·7	50·7	36·1	27·6	46·8	...
21·6	23·7	29·2	40·1	53·8	63·8	68·4	67·4	61·1	50·2	36·3	27·8	45·3	...
23·4	25·7	32·0	45·6	59·0	68·3	72·6	71·4	63·8	51·1	36·5	27·3	48·1	...
22·0	23·2	29·1	41·0	53·6	64·4	68·9	68·4	61·4	50·0	35·0	27·3	45·4	...
19·0	20·6	26·7	39·6	53·7	63·6	67·2	66·0	58·0	47·0	33·5	24·0	43·2	...
18·8	20·4	25·7	39·8	54·2	63·4	67·5	66·3	58·0	47·0	31·2	23·2	43·0	...
22·2	22·9	27·7	41·0	54·4	64·0	68·4	68·0	60·6	49·3	35·6	26·9	45·1	...
22·1	21·8	26·0	38·1	50·7	59·4	66·1	65·8	59·2	49·1	35·5	26·1	43·4	...
21·5	21·8	27·7	40·0	52·8	63·3	67·3	66·8	59·8	49·1	35·2	26·7	44·3	...
20·3	20·9	26·0	38·0	49·7	59·8	64·8	65·2	58·7	47·7	34·5	25·3	42·6	...
14·2	15·6	21·6	37·5	50·8	61·0	65·8	64·8	57·0	45·2	30·4	19·0	40·3	...
14·3	15·9	23·2	36·5	52·7	62·4	66·0	64·8	55·5	44·2	30·8	19·2	40·5	...
15·0	15·6	23·0	38·0	49·6	60·6	66·8	65·2	58·6	46·8	33·0	19·3	41·0	...
6·0	10·8	20·6	33·5	47·0	56·3	62·8	60·6	52·1	41·6	23·6	11·0	35·5	...
−9·8	−0·6	10·6	34·2	49·1	60·0	64·5	58·3	48·0	35·7	18·1	3·0	31·0	...
−9·0	−0·8	9·0	29·9	46·5	57·6	61·8	55·4	47·9	36·5	18·8	3·7	29·8	...
−6·9	−4·6	9·0	26·2	50·0	58·5	60·8	54·3	46·2	34·2	13·6	3·7	28·0	...
20·5	23·0	29·0	38·4	47·2	55·0	60·3	60·4	55·0	46·5	34·8	23·8	41·2	...
24·0	26·6	33·2	43·7	54·6	63·9	69·4	67·4	60·8	50·5	38·2	27·9	46·7	...
5·4	6·4	10·7	20·6	33·5	44·0	47·8	47·3	41·0	30·2	16·4	9·2	25·9	...
19·2	21·6	28·3	41·6	55·8	66·2	70·7	68·9	59·8	49·4	34·9	23·9	45·1	...
27·4	28·8	34·0	44·0	56·0	66·1	71·3	69·0	62·4	52·2	39·8	30·2	48·4	...
26·9	29·2	34·5	47·0	59·3	68·8	74·0	71·6	63·8	52·7	39·9	30·3	49·8	...
28·4	29·2	34·1	43·0	52·7	62·7	66·8	66·3	60·7	52·2	40·9	31·8	47·4	..
30·9	31·3	35·5	43·2	53·1	63·3	69·1	68·9	63·1	54·5	42·9	33·8	49·1	...
29·8	31·3	35·8	44·7	54·7	65·2	70·8	69·4	63·5	54·9	42·9	33·6	49·7	...
28·9	30·5	35·5	46·2	58·0	68·4	72·9	70·9	63·8	53·8	40·7	32·0	50·1	...
29·3	30·3	35·6	45·4	56·4	65·7	71·4	69·9	63·6	53·7	41·2	32·2	49·6	...
23·6	25·5	32·4	45·9	59·4	68·6	72·8	71·3	63·3	51·1	38·6	27·2	48·3	...
24·4	25·0	30·4	41·6	54·3	65·3	70·0	69·6	62·0	50·9	37·5	29·0	46·7	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.		Longitude.		Height, Feet.
					°	′	°	′	
New York, . .	New York	15	1870–84	7: 3, 11*	40	43	−74	0	164
Oswego, . .	do.	15	do.	do.	43	29	−76	35	304
Rochester, . .	do.	15	do.	do.	43	8	−77	42	621
Erie, . . .	Pennsylvania	15	do.	do.	42	7	−80	5	681
Philadelphia, .	do.	15	do.	do.	39	57	−75	9	92
Pittsburg, . .	do.	15	do.	do.	40	32	−80	2	762
Atlantic City, .	New Jersey	15	do.	do.	39	22	−74	25	13
Barnegat, . .	do.	15	do.	do.	39	46	−74	6	20
Cape May, . .	do.	15	do.	do.	38	56	−74	58	27
Sandy Hook, .	do.	15	do.	do.	40	28	−74	1	28
Baltimore, . .	Maryland	15	do.	do.	39	18	−76	37	45
Washington, .	Dist. Columbia	15	do.	do.	38	54	−77	2	106
Morgantown, .	Virginia	15	do.	do.	39	40	−79	52	963
Cape Henry, .	do.	15	do.	do.	36	56	−76	0	16
Wytheville, . .	do.	15	do.	do.	36	58	−81	5	2293
Lynchburgh, .	do.	15	do.	do.	37	25	−79	2	652
Norfolk, . .	do.	15	do.	do.	36	51	−76	17	30
Cape Hatteras, .	North Carolina	15	do.	do.	35	14	−75	30	7
Cape Lookout, .	do.	15	do.	do.	34	36	−76	36	18
Kittyhawk, . .	do.	15	do.	do.	36	0	−75	42	22
Smithville, . .	do.	15	do.	do.	33	55	−78	1	34
Wilmington, .	do.	15	do.	do.	34	14	−77	57	52
Charleston, . .	South Carolina	15	do.	do.	32	49	−79	56	52
Augusta, . .	Georgia	15	do.	do.	33	28	−81	54	183
Savannah, . .	do.	15	do.	do.	32	5	−81	5	87
Tybee Island, .	do.	15	do.	do.	32	0	−80	52	29
Jacksonville, .	Florida	15	do.	do.	30	20	−81	39	43
Key West, . .	do.	15	do.	do.	24	34	−81	49	20
Cedar Keys, . .	do.	15	do.	do.	29	8	−83	2	22
Punta Raasa, .	do.	15	do.	do.	26	29	−82	1	14
St. Marks, . .	do.	15	do.	do.	30	10	−84	12	15
Mobile, . .	Alabama	15	do.	do.	30	41	−88	2	41
Montgomery, .	do.	15	do.	do.	32	23	−86	18	219
Vicksburg, . .	Mississippi	15	do.	do.	32	22	−90	53	244
Knoxville, . .	Tennessee	15	do.	do.	35	56	−83	58	980
Memphis, . .	do.	15	do.	do.	35	9	−90	3	321
Nashville, . .	do.	15	do.	do.	36	10	−86	47	549
Louisville, . .	Kentucky	15	do.	do.	38	15	−85	45	530
Cincinnati, . .	Ohio	15	do.	do.	39	6	−84	30	620
Cleveland, . .	do.	15	do.	do.	41	30	−81	42	690
Toledo, . .	do.	15	do.	do.	41	40	−83	34	651
Columbus, . .	do.	15	do.	do.	39	58	−83	0	805
Sandusky, . .	do.	15	do.	do.	41	27	−82	40	639
Indianapolis, .	Indiana	15	do.	do.	39	46	−86	10	753
Cairo, . . .	Illinois	15	do.	do.	37	0	−89	10	377
Chicago, . .	do.	15	do.	do.	41	52	−87	38	661
Alpena, . .	Michigan	15	do.	do.	45	5	−83	30	609
Detroit, . .	do.	15	do.	do.	42	20	−83	3	661
Escanaba, . .	do.	15	do.	do.	45	48	−87	5	612
Grand Haven, .	do.	15	do.	do.	43	5	−86	19	620

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
30·3	31·7	36·6	47·2	59·2	68·9	73·6	72·3	65·6	55·7	42·8	33·2	51·4	...
26·2	26·7	32·0	43·0	54·5	64·9	70·4	69·3	62·1	51·6	39·0	29·3	47·5	...
24·6	25·6	30·8	43·6	57·0	66·6	70·7	69·3	62·5	50·3	36·6	28·1	47·1	...
27·5	27·8	33·5	45·0	58·0	68·0	71·8	70·8	64·0	53·8	40·0	31·2	49·3	...
32·1	34·3	39·6	50·0	62·2	72·0	76·4	73·9	67·2	56·5	44·0	34·9	53·6	...
31·1	33·5	38·8	50·9	62·6	70·9	74·3	72·4	65·7	55·1	41·0	33·3	52·5	...
32·5	33·6	38·2	47·2	57·1	66·6	72·2	72·3	67·2	57·2	44·1	35·4	51·9	...
32·2	33·2	38·2	46·5	56·8	66·3	72·0	71·7	66·4	56·6	43·4	34·6	51·5	...
34·7	36·4	41·0	48·1	59·0	68·0	73·5	72·9	68·1	59·0	46·7	38·2	53·9	...
31·2	32·3	37·4	47·4	59·4	68·6	73·8	73·2	67·0	56·9	44·5	34·6	52·2	...
35·4	37·4	42·6	53·7	64·8	74·0	78·5	75·4	68·3	58·3	45·1	36·1	55·8	...
33·8	36·3	42·2	52·7	64·2	73·9	78·9	75·1	68·2	58·0	44·3	36·6	55·3	...
35·2	37·6	41·8	52·0	63·0	70·8	74·2	71·5	64·8	54·9	43·6	36·8	53·8	...
40·6	42·1	45·8	54·0	64·2	73·3	78·1	76·4	72·0	61·8	51·4	43·1	58·6	...
35·0	38·4	42·0	52·5	64·4	68·0	71·8	70·2	67·0	54·8	41·7	35·8	53·5	...
37·4	41·3	45·8	56·3	66·6	74·7	79·0	75·9	69·2	58·9	46·5	38·9	57·7	...
40·7	43·4	48·0	56·1	66·0	75·5	79·6	76·9	71·1	61·3	50·0	42·1	59·2	...
45·7	46·5	50·3	56·4	64·9	74·2	78·1	77·5	73·2	64·3	55·1	47·4	61·1	...
47·2	48·3	53·0	59·0	67·0	75·7	80·0	79·0	75·3	66·0	55·5	48·1	62·8	...
42·5	43·9	47·4	54·2	62·8	73·0	79·8	77·2	72·6	63·4	52·6	44·2	59·5	...
46·6	48·8	53·8	60·4	69·6	77·2	81·0	79·3	74·2	64·6	54·0	47·5	63·1	...
47·7	50·2	54·7	61·4	69·3	76·6	80·3	78·6	73·7	64·3	55·0	48·0	63·3	...
50·8	53·3	57·8	64·7	72·5	79·4	82·8	80·9	76·6	67·5	57·9	51·5	66·3	...
48·3	51·3	56·6	64·2	72·7	79·1	82·0	80·2	74·8	65·1	55·5	48·2	64·8	...
52·2	54·9	60·0	66·3	73·7	80·1	83·1	81·5	76·3	67·4	58·3	52·9	67·2	...
49·7	53·0	58·5	63·8	71·6	77·9	80·2	80·0	76·2	67·7	58·5	51·1	65·7	...
56·1	58·2	62·8	69·6	75·7	80·6	82·9	81·5	78·0	71·2	62·1	56·3	69·6	...
70·8	71·9	74·0	76·7	79·6	83·0	83·9	84·4	83·1	79·1	74·9	70·9	77·7	...
56·9	60·3	63·3	70·2	76·3	80·6	83·2	81·8	79·3	72·3	63·6	58·3	70·5	...
64·7	65·6	69·5	73·1	76·9	80·4	81·6	81·4	80·1	76·5	70·0	65·4	73·8	...
53·2	56·0	60·8	66·4	73·6	78·5	81·3	79·9	77·1	68·1	59·5	53·9	67·4	...
51·1	54·6	59·9	66·9	74·6	80·5	82·2	81·0	77·0	68·2	58·0	52·0	67·2	...
49·0	52·9	58·1	65·4	73·2	79·5	82·5	80·1	75·5	66·5	54·9	49·3	65·5	...
48·3	53·5	59·6	66·0	74·0	80·0	82·2	81·3	75·5	66·5	55·4	50·4	66·1	...
38·0	42·1	47·7	57·3	67·4	73·5	76·4	75·2	68·6	58·5	46·3	39·2	57·4	...
40·4	45·2	51·9	61·3	70·7	78·0	80·9	78·9	71·6	63·3	49·5	42·4	61·2	...
39·1	43·8	49·7	59·2	69·6	77·0	80·0	78·2	70·8	60·9	48·1	41·5	60·0	...
35·2	39·2	45·1	56·0	67·2	75·0	78·9	76·8	69·0	59·2	45·3	37·6	57·0	...
34·2	38·1	43·6	54·7	66·4	74·4	78·0	76·0	68·5	58·7	45·1	36·8	56·2	...
26·7	28·6	34·0	45·4	58·3	67·3	72·0	70·3	64·2	53·8	39·2	30·2	49·2	...
28·0	30·3	36·2	48·8	61·6	70·6	74·2	72·1	64·6	54·0	39·7	31·0	51·0	...
30·6	36·8	39·6	51·8	63·9	71·2	74·6	73·6	68·6	58·6	42·6	33·7	53·8	...
28·0	33·0	35·0	45·5	61·3	68·6	72·0	71·3	67·4	56·3	41·4	31·9	51·0	...
29·8	34·4	40·2	52·8	64·7	73·0	77·0	74·1	66·8	55·8	41·1	32·5	53·5	...
34·4	40·8	46·7	58·0	67·5	75·7	79·2	77·5	70·3	58·9	45·8	39·2	57·8	...
25·5	29·3	35·4	46·3	57·5	67·7	72·9	72·2	64·4	53·4	38·8	29·0	49·4	...
19·1	19·5	25·0	37·0	49·5	59·3	66·1	64·8	57·2	46·6	32·7	23·7	41·7	...
24·6	27·2	33·0	45·3	58·7	68·0	72·0	70·5	62·3	52·3	36·9	29·2	48·4	...
15·4	16·9	22·7	36·3	50·4	61·2	67·1	66·5	56·5	45·0	31·0	20·6	40·8	...
25·6	26·5	32·0	43·7	55·9	64·6	69·7	68·7	61·3	51·0	37·6	29·0	47·1	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Marquette, . .	Michigan	15	1870–84	7 : 3, 11*	46 34	−87 24	673
Port Huron, . .	do.	15	do.	do.	43 0	−82 26	633
La Crosse, . .	Wisconsin	15	do.	do.	43 49	−91 15	725
Milwaukee, . .	do.	15	do.	do.	43 2	−87 54	697
Breckenridge, .	Minnesota	15	do.	do.	46 11	−96 17	968
Duluth, . .	do.	15	do.	do.	46 48	−92 6	672
St. Paul's, . .	do.	15	do.	do.	44 58	−93 3	801
Bismarck, . .	Dacota	$10\frac{1}{4}$	1874–84	do.	46 47	−100 36	1694
Fort Buford, .	do.	15	1870–84	do.	48 0	−103 56	1930
Fort Sully, . .	do.	15	do.	do.	44 39	−100 40	1678
Saint Vincent, .	do.	15	do.	do.	48 56	−97 14	804
Pembina, . .	do.	15	do.	do.	49 0	−97 5	791
Deadwood, . .	do.	15	do.	do.	44 23	−103 43	4600
Yankton, . .	do.	15	do.	do.	42 54	−97 28	1228
Virginia City, .	Montana	9	1872–80	do.	45 20	−112 3	5480
Boise City, . .	Wyoming	15	1870–84	do.	43 37	−116 8	2750
Lewiston, . .	do.	15	do.	do.	46 8	−117 5	780
Cheyenne, . .	do.	15	do.	do.	41 12	−104 42	6105
Fort Benton, .	do.	5	1880–84	do.	47 50	−110 40	2694
North Platte, .	Nebraska	15	1870–84	do.	41 8	−100 45	2841
Omaha, . .	do.	15	do.	do.	41 16	−95 56	1113
Davenport, . .	Iowa	15	do.	do.	41 32	−90 38	603
Dubuque, . .	do.	15	do.	do.	42 30	−90 44	665
Keokuk, . .	do.	15	do.	do.	40 22	−91 26	618
St. Louis, . .	do.	15	do.	do.	38 37	−90 12	571
Dodge City, . .	Kansas	$10\frac{1}{4}$	1874–84	do.	37 45	−100 0	2517
Leavenworth, .	do.	15	1870–84	do.	39 19	−94 57	842
Denver, . .	Colorado	15	do.	do.	39 45	−105 0	5294
Pike's Peak, . .	do.	$11\frac{1}{4}$	1873–84	do.	38 50	−105 2	14134
Salt Lake City, .	Utah	$10\frac{3}{4}$	1874–84	do.	40 46	−111 54	4348
Fort Smith, . .	Arkansas	15	1870–84	do.	35 22	−94 24	449
Little Rock, . .	do.	15	do.	do.	34 45	−92 6	298
Corsicana, . .	do.	15	do.	do.	32 5	−96 30	445
Denison, . .	do.	15	do.	do.	33 48	−96 32	767
Fort Gibson, .	Indian Territory	15	do.	do.	35 50	−95 20	540
New Orleans, .	Louisiana	15	do.	do.	29 58	−90 4	52
Port Eads, . .	do.	15	do.	do.	29 9	−89 15	7
Shreveport, . .	do.	15	do.	do.	32 30	−93 40	227
Galveston, . .	Texas	15	do.	do.	29 18	−94 47	40
Indianola, . .	do.	15	do.	do.	28 32	−96 31	26
Palestine, . .	do.	15	do.	do.	31 45	−95 40	533
Brownsville, . .	do.	15	do.	do.	25 53	−97 26	59
Rio Grande City, .	do.	15	do.	do.	26 22	−98 48	230
Eagle Pass, . .	do.	15	do.	do.	31 47	−106 30	780
San Antonio, .	do.	15	do.	do.	29 25	−98 25	673
Concho, . .	do.	15	do.	do.	31 25	−100 24	1900
Stockton, . .	do.	15	do.	do.	30 53	−102 53	3010
Jacksonburgh, .	do.	15	do.	do.	32 12	−98 10	1120
El Paso, . .	New Mexico	15	do.	do.	31 35	−106 26	3764
Santa Fé, . .	do.	13	1870–82	do.	35 41	−105 57	7106

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
18·0	19·2	24·4	37·3	49·4	58·7	65·2	64·6	56·5	46·4	31·3	22·4	41·4	...
21·4	23·4	29·0	39·7	52·6	63·5	68·3	68·0	60·9	49·0	35·3	26·8	44·9	...
16·7	22·0	31·2	47·4	61·2	69·2	72·9	71·2	61·8	50·3	33·7	22·4	46·6	...
20·6	25·0	30·8	42·5	52·6	63·8	69·4	68·8	61·5	50·0	34·6	24·6	45·3	...
2·8	8·1	18·6	39·5	56·3	64·4	68·7	66·8	55·5	43·0	23·9	10·3	38·1	...
11·9	16·6	24·8	38·6	48·9	58·1	66·7	65·0	57·3	45·4	28·8	16·2	39·9	...
12·0	18·4	28·3	45·2	59·3	68·0	71·8	69·4	59·3	47·5	30·2	17·3	44·0	...
5·8	11·4	21·7	40·0	55·0	63·8	69·4	68·1	55·8	42·3	25·0	13·4	39·3	...
4·4	10·7	22·7	40·4	54·2	63·3	68·3	67·0	54·0	40·7	24·1	10·2	38·4	...
12·8	19·7	26·7	42·7	59·0	69·3	74·7	73·0	61·6	48·2	30·7	20·3	44·9	...
−5·0	3·7	13·5	34·5	51·3	61·4	64·7	63·6	52·4	40·0	19·3	5·7	33·4	...
−3·0	3·8	13·8	34·8	53·6	63·8	66·6	64·6	52·3	39·5	18·7	3·4	35·2	...
20·4	24·8	30·3	39·0	49·7	60·0	64·7	62·8	53·0	42·8	30·5	23·7	41·8	...
15·1	21·3	29·8	46·1	59·9	69·7	73·9	72·5	61·6	49·2	32·1	19·4	45·9	...
18·5	23·5	29·3	37·4	46·2	55·8	64·4	63·0	52·3	42·5	28·5	21·3	40·2	...
29·5	33·8	41·4	48·1	56·9	66·4	73·6	71·6	59·9	48·0	36·9	31·2	48·9	...
31·8	34·0	43·7	50·6	58·6	67·5	73·5	72·8	61·2	49·7	38·6	31·6	50·3	...
25·0	27·8	33·2	40·6	52·6	62·6	68·6	66·1	55·8	41·3	33·0	27·0	44·8	...
13·8	18·2	30·5	42·7	54·8	63·5	69·8	68·6	55·8	44·4	28·6	17·0	42·3	...
19·5	26·6	35·0	47·0	59·2	69·8	74·5	72·6	61·7	49·7	34·4	24·5	47·9	...
21·1	27·6	35·5	50·1	62·6	72·2	76·2	74·4	63·7	52·9	36·5	24·9	49·8	...
22·2	28·2	35·4	49·6	61·9	71·2	75·8	73·3	64·6	52·6	37·4	27·4	49·2	...
19·1	25·2	32·8	47·8	60·8	69·8	75·0	73·0	63·4	50·8	34·5	26·3	48·2	...
25·4	31·3	39·6	52·0	64·1	73·0	77·7	75·6	66·9	55·1	39·7	29·8	52·5	...
31·1	36·0	43·1	55·5	66·1	74·7	78·4	76·8	69·2	58·2	43·4	34·2	55·6	...
26·0	33·2	42·0	52·7	62·6	73·3	77·5	74·8	66·6	54·3	37·2	30·0	52·5	...
26·0	32·6	41·0	53·8	64·9	74·0	77·9	76·4	67·0	56·3	40·4	30·0	53·3	...
27·8	33·2	39·8	46·6	57·8	68·0	73·2	70·6	61·4	49·5	36·8	29·2	49·5	...
2·8	3·6	7·8	12·7	22·2	33·3	40·3	38·8	31·3	21·5	10·8	6·0	19·3	...
28·7	32·8	41·6	49·3	58·2	68·7	76·3	74·9	64·2	51·6	38·8	32·6	51·3	...
36·8	42·1	51·5	60·4	69·5	76·0	80·2	77·3	72·3	63·2	49·0	40·0	59·8	...
41·2	48·0	54·0	62·3	70·7	78·1	81·0	79·4	72·5	63·8	50·7	45·1	62·2	...
44·8	51·8	58·4	65·7	73·3	79·7	83·9	83·2	76·1	67·7	53·9	47·8	65·4	...
42·9	48·8	56·5	63·8	71·9	78·8	83·0	82·4	75·0	64·8	50·3	43·8	63·5	...
37·8	43·0	51·3	59·4	69·6	77·3	81·5	79·4	72·3	60·6	47·5	38·5	59·8	...
54·1	58·4	62·6	68·5	74·8	80·7	82·5	81·9	78·0	70·8	61·5	56·0	69·1	...
55·4	57·4	61·8	68·4	74·0	78·6	81·5	81·7	79·2	72·5	64·6	58·0	69·4	...
46·0	52·1	58·8	65·8	73·9	80·6	83·3	82·4	75·6	66·6	54·0	48·5	65·6	...
52·8	57·3	63·6	69·1	76·0	82·2	83·8	83·4	78·9	72·9	61·9	56·2	69·9	...
53·0	58·2	65·0	70·0	76·1	82·3	83·8	83·5	79·3	73·0	62·3	56·4	70·2	...
46·7	52·6	59·6	65·2	72·4	79·1	81·7	81·3	75·4	66·6	55·4	49·0	65·4	...
58·5	62·8	68·9	74·4	79·4	83·0	84·6	83·2	79·8	75·2	65·3	60·4	73·0	...
58·5	63·3	70·2	76·5	80·8	85·2	86·4	83·1	81·8	74·0	64·0	59·6	73·6	...
51·5	57·5	65·7	73·2	79·1	85·2	87·0	84·4	80·3	72·7	59·4	53·2	70·8	...
51·0	56·3	63·5	70·0	75·7	81·8	83·3	82·2	78·0	71·6	59·0	53·7	69·0	...
43·5	48·3	58·6	64·5	72·4	80·2	83·8	80·2	73·6	65·4	51·2	44·8	64·1	...
43·8	48·5	57·8	64·0	71·7	79·4	82·3	78·0	71·6	64·0	50·4	45·0	63·0	...
43·0	48·7	58·4	65·2	73·3	80·5	83·7	82·0	74·6	67·8	52·5	44·4	64·5	...
46·9	50·6	57·4	64·6	73·3	81·0	81·8	78·6	72·8	64·3	50·5	46·3	64·0	...
28·2	31·7	39·8	46·6	57·4	66·8	68·8	66·8	59·9	49·9	36·3	30·0	48·5	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Tucson, . .	Arizona	15	1870–84	7: 3, 11*	32 14	–110 53	2369
Yuma, . . .	do.	14	1871–84	do.	32 45	–114 36	141
Prescott, . .	do.	14	do.	do.	34 33	–112 28	5340
Tatoosh, . .	do.	15	1870–84	do.	48 23	–124 44	86
Olympia, . .	do.	15	do.	do.	47 3	–122 53	36
Canby, . . .	Oregon	15	do.	do.	46 16	–124 4	179
Portland, . .	do.	15	do.	do.	45 32	–122 43	67
Umatilla, . .	do.	15	do.	do.	45 55	–119 20	340
Cape Mendocino, .	California	15	do.	do.	40 26	–124 24	637
Roseburg, . .	do.	15	do.	do.	43 13	–123 20	511
Red Bluff, . .	do.	15	do.	do.	40 10	–122 15	332
Sacramento, . .	do.	15	do.	do.	38 35	–121 30	65
San Francisco, .	do.	15	do.	do.	37 48	–122 26	60
Visalia, . .	do.	15	do.	do.	36 20	–119 17	348
Los Angelos, .	do.	15	do.	do.	34 3	–118 15	371
San Diego, . .	do.	15	do.	do.	32 43	–117 10	67
Winnemucca, .	Nevada	15	do.	do.	40 59	–117 43	4327
Mexico, . .	Mexico	9	1877–85	hourly	19 26	–99 0	7490
Puebla, . .	do.	8	1878–85	7: 2, 9	19 3	–98 3	7113
Colima, . .	do.	11	1869–80	do.	19 12	–103 33	270
Mazatlan, . .	do.	6	1880–85	M.m.	23 11	–106 17	249
Vera Cruz, . .	do.	3	1863–65	M.T.	19 12	–96 9	26
Cordova, . .	do.	5	1861–65	9: 9	18 51	–96 54	2879
Guatemala, . .	Guatemala	4	1879–82	7: 2, 9	14 38	–90 31	4856
Beliza, . . .	B. Honduras	5	1865–69	M.m.	17 30	–88 18	27
Rivas, . . .	Nicaragua	7	1880–86	M.T.	11 26	–85 47	150
Bluefields, . .	do.	3	1883–86	do.	12 8	–83 43	20
San José, . .	Costa Rico	11	1868–78	7: 2, 9, 9	9 56	–84 0	3756
Colon, . . .	Panama	5	1881–85	M.m.	9 22	–79 55	164
Kaos, . . .	do.	3	1883–85	do.	8 57	–79 31	46
Gamboa, . .	do.	4	1881–82, '84–85	do.	9 10	–79 43	98
Bermuda, . .	West Indies	15	1870–84	M.T.	32 17	–64 14	120
Nassau, . .	do.	15	do.	M.m.	25 5	–77 21	44
Havana, . .	do.	19	1858–76	4, 10: 4, 10	23 8	–82 23	62
Matanzas, . .	do.	2	?	S.R.: 2, S.S., M.m.	23 2	–81 38	117
Santiago, . .	do.	3	1881–83	M.T.	19 55	–75 50	21
Up Park Camp, .	do.	5	1853–59	M.m.	18 0	–76 56	225
Ross's View, . .	do.	5	1869–73	6: 6	18 3	–76 44	951
Kingston, . .	do.	8	1880–87	M.m.	18 1	–76 48	10
Cinchona Plain, .	do.	3	1882–85	do.	18 5	–76 44	4850
Navassa, . .	do.	2½	1880–82	M.T.	19 25	–75 3	77
St. Croix, Christian-stadt, . .	do.	9	1877–85	M.m.	17 45	–64 42	81
S. Juan de Porto Rico,	do.	12	1874–85	do.	18 18	–66 30	82
Sanchez, . .	do.	2	1886–87	do.	19 13	–69 37	50
La Pointe-à-Pitre,	do.	7	1878–84	do.	16 14	–61 31	13
Barbadoes, . .	do.	15	1870–84	do.	13 4	–59 40	25
St. Ann's, Trinidad,	do.	18	1862–80	M.T.	10 30	–61 20	130
Maracaibo, . .	Venezuela	1	?	7: 3	10 43	–71 52	[0]
La Guayra, . .	do.	?	?	6, 10: 4, 9	10 37	–67 7	[0]

* Washington Mean Time.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
48·6	52·8	58·6	64·2	73·0	82·9	86·2	83·7	79·0	69·6	57·0	50·7	67·1	...
53·2	56·5	63·5	68·6	77·3	86·0	92·0	91·3	84·8	72·3	60·8	55·8	72·0	...
34·8	36·6	43·6	49·6	58·5	68·8	72·8	71·1	65·0	53·8	41·5	37·2	52·8	...
41·0	41·8	43·4	47·2	49·8	53·8	56·0	55·6	55·0	50·8	46·6	43·0	48·6	...
37·8	40·8	43·8	48·2	53·6	59·5	62·8	62·2	56·4	50·0	43·6	38·3	49·7	...
41·3	43·8	45·5	49·2	52·5	56·0	58·2	59·2	57·5	53·6	48·3	43·8	50·7	...
39·5	41·7	46·7	51·8	56·9	62·4	67·2	66·0	60·8	53·2	45·5	40·5	52·7	...
32·3	36·4	47·7	53·6	59·9	68·1	74·0	72·8	63·9	51·7	40·9	33·4	52·9	...
48·5	48·0	48·6	49·8	51·7	54·8	56·6	56·8	56·0	55·4	52·3	50·0	52·4	...
40·8	44·2	46·9	51·1	55·5	62·7	66·5	65·6	60·4	50·6	44·4	41·4	52·4	...
46·2	49·4	54·3	59·0	67·0	78·0	83·2	80·5	73·7	62·8	52·9	46·8	62·9	...
46·5	50·3	54·6	58·4	64·4	70·8	73·3	72·2	69·0	60·8	52·8	47·1	60·0	...
50·4	51·9	53·4	54·5	56·5	58·6	58·5	58·4	59·4	59·2	55·6	51·7	55·7	...
45·8	50·4	55·3	59·6	67·3	76·5	81·1	79·4	71·4	61·6	50·3	46·8	62·1	...
52·2	53·8	55·6	58·0	61·8	65·4	68·5	69·6	67·2	63·0	58·3	54·5	60·7	...
53·2	54·0	56·0	57·8	61·4	64·5	67·7	68·8	66·5	63·0	57·8	55·0	60·5	...
30·6	34·7	39·5	47·5	54·4	66·5	74·1	72·0	61·2	47·0	35·5	32·2	49·6	...
53·8	56·7	61·0	65·1	64·8	63·9	62·4	62·2	61·0	59·2	56·5	54·0	60·1	...
53·4	55·8	60·8	65·0	65·0	64·6	63·3	62·8	62·1	60·8	57·6	54·3	60·4	...
76·1	73·4	78·8	80·8	81·0	82·8	83·3	78·8	79·2	78·6	77·9	77·0	79·0	...
66·0	65·3	67·1	69·6	74·4	80·0	80·5	79·7	79·7	78·3	73·8	70·3	73·7	...
70·4	74·0	77·4	80·1	84·5	85·8	82·9	82·5	81·7	80·4	74·8	72·3	78·9	...
63·9	65·8	68·7	71·8	73·6	72·3	71·2	71·6	70·7	69·0	65·3	64·0	68·9	...
61·9	62·1	66·8	68·6	69·6	67·6	66·7	66·6	66·4	65·5	63·5	62·0	65·6	...
76·1	77·0	79·3	80·8	82·6	82·8	82·4	83·0	82·8	80·2	77·0	76·3	80·1	...
80·6	80·0	79·6	81·2	81·4	80·1	79·4	79·6	80·0	79·5	80·5	80·2	80·2	...
79·1	78·6	81·6	83·4	81·7	80·0	80·3	80·2	80·0	80·5	80·0	79·4	80·4	...
69·8	72·7	72·9	74·3	72·7	71·2	70·9	70·3	70·5	69·6	69·3	68·5	71·1	...
79·0	78·8	78·9	79·3	80·1	79·7	79·2	78·6	78·0	78·7	79·6	79·6	79·1	...
79·2	78·6	78·4	80·2	81·9	80·2	80·1	81·8	81·4	80·2	79·6	79·5	80·2	...
76·3	75·8	76·3	77·5	79·3	80·0	79·1	79·0	79·6	79·1	79·3	77·7	78·3	...
62·9	62·6	62·5	65·4	69·9	75·9	79·8	80·4	78·7	73·3	68·3	64·2	70·4	...
72·2	72·6	73·5	75·8	77·8	80·6	81·8	82·2	81·6	79·2	76·0	72·9	77·2	...
72·6	73·0	75·7	77·8	80·8	83·4	83·7	83·3	82·0	79·5	76·8	72·6	78·5	...
73·5	72·1	75·8	80·2	80·7	82·1	81·5	80·6	82·2	78·8	77·7	74·7	79·2	...
75·6	74·1	75·3	79·4	80·6	82·8	82·9	83·4	81·8	79·5	78·0	76·3	79·1	...
77·8	76·0	76·8	77·3	79·0	80·6	79·9	81·6	81·0	80·4	80·6	78·3	79·1	...
68·4	68·7	69·6	71·4	72·7	74·8	75·0	74·1	73·8	72·1	71·1	68·9	71·8	...
76·5	76·3	76·5	77·7	79·4	80·5	81·6	81·1	81·5	80·5	79·4	77·7	79·1	...
59·9	59·2	59·6	61·9	62·6	64·8	65·7	65·6	65·1	63·4	62·1	61·3	62·6	...
75·4	74·1	75·8	77·0	81·0	82·7	82·7	82·8	82·2	81·2	78·7	75·8	79·1	...
78·0	77·9	78·6	80·3	82·0	83·1	83·2	83·8	83·5	82·2	80·3	78·3	80·9	...
76·8	76·3	78·6	80·2	81·6	83·2	83·0	83·5	82·5	82·8	81·0	77·8	80·7	...
73·9	74·0	75·6	77·3	78·5	79·3	79·9	80·6	81·0	79·5	77·5	74·2	77·6	...
75·0	74·8	76·1	78·4	81·0	82·0	81·8	81·8	81·3	80·1	78·4	75·6	78·8	...
78·9	79·0	79·8	80·8	81·9	81·9	81·6	81·8	81·8	81·4	80·8	79·6	80·7	...
78·1	78·0	78·6	80·1	81·3	80·6	80·2	80·4	81·0	81·0	80·3	80·8	79·9	+2·0
81·2	83·4	82·9	86·4	85·8	86·6	86·6	86·9	86·5	85·0	84·0	81·9	84·8	...
76·6	76·5	77·5	78·4	79·4	79·8	79·3	80·7	81·1	80·7	79·7	77·0	78·9	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Caraccas,	Venezuela	3	1868–70	M.T.	10 30	−66 55	3043
Colonia Tovar,	do.	1½	1854–56	7 : 2, 9	10 26	−67 20	5649
Medillin,	Colombia	5	1875–79	M.m.	6 10	−75 45	4951
Buenaventura,	do.	1	1881–82	M.T.	3 50	−75 55	18
Bogota,	do.	2	1823–24	6 : 1, 9	4 35	−74 14	8727
Puerto Berrio,	do.	5	1880–85	M.T.	6 22	−74 28	542
Quito,	Ecuador	1½	1878–79	6 : 2, 10	−0 14	−78 45	9350
Do.	do.	5/6	1858–59	9 : 9	−0 14	−78 45	9350
Iquitos,	do.	?	?	M.T.	−3 44	−73 8	312
Antisana,	do.	1	1845–46	M.m.	−0 21	−78 6	13320
George Town,	British Guiana	8	1846–56	do.	6 50	−58 8	10
Paramaribo,	Surinam	15	1870–84	8 : 8	5 50	−55 13	6
Catherina Sophia,	do.	4	1852–56	6 : 6	5 48	−56 47	50
Cayenne,	French Guiana	7	1846–52	M.T.	4 56	−55 39	7
Manaos,	Brazil	5/6	1866, '68–69	do.	−3 8	−60 0	121
Para,	do.	3	1848, etc.	S.R., N. : 8	−1 30	−48 24	[0]
Ceara,	do.	1	1860	7 : 2, 6	−3 43	−38 35	[0]
Porto do Maranhao,	do.	1½	1886–87	M.m.	−2 30	−44 0	14
Parnahylu	do.	1	1883	do.	−6 13	−42 45	[0]
Pernambuco,	do.	8	1876–84	7 : 1	−8 4	−34 52	11
" Do.	do.	2½	?	M.m.	−8 4	−34 52	11
Colonia Isobel,	do.	6	1876–84	do.	−8 45	−35 42	751
Victoria,	do.	7	do.	do.	−8 9	−35 27	528
Bahia,	do.	3½	1881–84	M.T.	−12 58	−38 30	330
St. Bento das Lagas,	do.	10	1872–81	do.	−12 37	−38 40	98
Nova Friburgo,	do.	4	1882–86	M.m.	−22 19	−42 30	2874
Rio de Janeiro,	do.	35	1851–85	do.	−22 57	−43 7	224
San Paulo,	do.	5	1879–83	9 : 9	−23 33	−46 37	2393
Queluz,	do.	2½	1882–83, '87	M.T.	−20 40	−44 38	3285
Taquara,	do.	1½	1869–71	do.	−29 40	−50 47	?
São Leopoldo and Santa Cruz,	do.	5	1869–73	do.	−29 35	−52 30	361
Passo Fundo,	do.	1	1880–81	7 : 1, 9	−28 13	−52 12	2060
Pelotas,	do.	3	1875–77	M.m.	−31 47	−52 19	20
Rio Grande do Sul,	do.	9	1877–79, '82–87	M.T.	−32 0	−52 15	54
S. Antonio de Palmeira	do.	1⅔	1879–80	7 : 1, 9, 9	−27 54	−53 26	1896
Joinville,	do.	8	1867–75	6 : 2, 10	−26 19	−53 48	?
Lima,	Peru	1	1869	9, N. : 6, M.	−12 3	−77 6	499
Do.	do.	2	?	noon	−12 3	−77 6	565
Callao,	do.	?	1857–70	?	−12 4	−77 14	[0]
Arica,	do.	1¼	1854–55	M.T.	−18 25	−70 22	10
Cochabamba,	Bolivia	1½	1883–84	do.	−17 21	−65 52	7244
Iquique,	do.	3	1883–86	do.	−20 12	−70 11	30
Punta Caldera,	Chili	3	do.	do.	−27 5	−70 50	82
Copiapo,	do.	5	1868–72	9 : 9	−27 22	−70 23	1296
Serena,	do.	4	1869–72	do.	−29 55	−71 17	115
Coquimbo,	do.	4	do.	do.	−29 56	−71 21	74
Valparaiso,	do.	5	1868–72	do.	−33 1	−71 40	151
Do.	do.	10	1863–72	M.T.	−33 1	−71 40	151
Santiago de Chili,	do.	21	1860–81	M.m.	−33 27	−70 41	1703

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
68·5	68·9	69·3	72·5	73·9	73·0	72·0	72·6	72·5	71·4	71·2	68·9	71·2	...
55·2	57·1	58·4	60·3	59·7	58·4	58·5	60·7	59·8	59·5	58·3	56·7	58·6	...
70·9	71·6	70·9	70·7	70·9	70·7	70·5	70·7	70·5	69·4	69·1	69·8	70·5	...
80·0	80·0	79·5	(78·3)	78·9	79·7	79·7	79·6	(78·4)	77·6	78·0	78·6	79·0	...
57·0	58·1	59·2	58·5	58·3	57·6	56·3	56·1	57·0	58·5	59·0	58·6	57·9	...
79·4	79·4	78·4	78·0	78·8	79·0	78·5	78·3	78·7	78·3	79·0	79·2	78·7	...
56·5	57·0	55·2	53·6	56·1	54·9	54·5	55·8	55·4	55·9	56·5	56·1	55·6	...
57·4	58·8	57·4	56·5	54·7	57·6	...	...	57·8	57·2	56·3	57·4	...	...
77·5	78·5	76·3	77·0	75·6	74·3	74·1	76·3	76·3	77·2	78·4	77·9	76·6	...
43·2	41·2	42·1	42·6	41·9	40·1	37·4	37·4	39·2	41·0	41·9	42·8	40·8	...
78·9	78·6	79·1	79·8	79·5	78·9	78·6	79·9	80·8	80·8	80·3	78·9	79·5	...
79·3	79·6	80·4	81·1	81·5	82·0	83·0	83·7	83·7	83·5	82·2	80·0	81·7	...
77·2	77·6	77·7	78·0	78·3	77·5	77·6	78·5	78·6	78·7	78·0	77·0	77·9	...
79·1	79·0	79·4	80·0	79·9	79·9	80·5	81·4	81·8	82·0	81·4	79·1	80·3	...
78·4	79·3	78·8	77·5	78·6	78·6	78·6	(79·5)	(80·0)	80·4	80·6	80·2	79·2	...
80·1	78·9	78·9	79·3	80·6	80·6	81·5	81·5	81·2	81·5	81·9	81·3	80·6	...
81·3	79·7	79·9	79·9	78·8	77·4	77·4	79·2	79·4	80·2	81·5	81·1	79·5	...
(82·0)	81·8	81·6	80·1	81·2	81·1	81·3	82·2	(83·0)	(83·0)	82·6	82·0	81·8	...
77·7	80·1	78·3	79·7	81·5	79·5	81·0	82·2	84·6	84·4	81·1	79·3	80·8	...
82·2	82·4	81·5	79·3	77·7	76·1	74·3	75·6	77·5	80·2	81·3	82·0	79·2	...
80·5	80·5	79·7	78·3	77·3	75·6	75·0	75·2	76·8	78·8	80·0	80·2	78·2	...
77·0	75·9	77·4	76·1	74·1	72·1	70·5	70·3	72·0	74·5	76·6	77·2	74·7	...
79·6	80·1	79·0	78·4	76·8	75·0	73·4	73·8	74·5	76·6	78·8	79·2	77·2	...
82·8	82·5	82·4	80·2	78·4	76·1	74·8	75·2	77·0	79·1	79·9	82·0	79·2	...
79·7	80·1	79·7	78·3	75·7	73·8	72·3	72·5	74·0	76·6	78·8	79·7	76·6	...
68·5	68·6	67·8	66·9	62·3	57·0	57·8	58·2	61·4	63·8	65·6	68·1	63·8	...
79·0	79·1	79·3	76·8	73·1	71·5	70·1	70·1	70·5	72·9	75·0	77·5	74·3	...
70·9	70·3	68·7	64·8	59·9	57·2	56·7	58·1	61·7	64·8	67·5	69·1	64·0	...
72·1	73·0	72·8	68·4	62·8	60·2	59·6	62·2	66·8	68·5	71·4	71·6	67·5	...
75·7	75·2	74·7	65·7	60·4	61·7	55·3	55·1	58·8	64·4	68·9	73·0	65·7	...
76·6	77·5	74·8	66·7	60·8	58·8	54·7	57·9	62·2	64·0	70·9	75·0	66·7	...
73·4	71·6	70·3	60·8	56·7	56·0	50·5	51·8	57·9	60·3	71·4	(72·5)	62·8	...
75·6	74·4	72·6	65·9	58·8	53·2	53·5	56·2	59·0	61·9	66·4	71·7	64·0	...
75·9	74·8	73·0	67·3	60·8	57·3	56·3	58·8	61·0	64·5	69·9	72·8	66·0	...
73·7	71·6	70·2	65·8	57·7	54·9	59·0	59·3	61·2	67·5	71·4	73·2	64·7	...
77·0	76·1	73·8	70·7	64·9	62·4	60·3	63·1	65·1	68·7	71·6	75·2	69·0	...
74·3	75·0	73·4	69·4	63·8	59·8	57·6	58·5	59·9	62·0	63·1	67·5	65·3	...
78·1	79·9	80·0	77·3	77·9	68·4	68·5	67·3	66·2	69·2	72·0	74·9	73·3	...
70·9	70·7	71·6	68·0	67·1	61·7	60·8	60·5	60·8	65·3	68·9	70·7	66·4	...
71·6	71·4	70·3	68·0	66·0	64·8	63·7	63·1	63·0	66·0	69·1	71·6	67·5	...
65·8	66·2	64·8	65·7	62·2	57·8	59·4	62·2	64·0	68·0	66·2	64·2	63·9	...*
70·6	69·5	67·2	64·3	62·2	60·5	59·5	59·8	62·6	63·9	66·2	69·8	64·6	...
68·1	67·8	66·5	63·7	58·8	57·3	55·5	56·8	58·0	60·3	62·5	66·3	61·8	...
68·7	66·7	64·2	59·0	55·2	51·6	50·7	53·6	56·5	59·5	62·2	65·7	59·5	...
64·0	64·6	61·9	58·5	56·1	53·2	52·5	54·3	55·4	57·7	60·1	62·2	58·5	...
65·1	64·7	62·6	60·3	57·9	54·7	54·5	55·6	56·7	60·1	63·1	65·7	60·1	...
63·1	62·7	60·3	56·3	54·3	52·9	52·5	53·2	54·0	57·4	59·7	62·4	57·4	...
63·0	63·0	60·5	57·4	55·1	53·3	52·8	52·8	54·1	57·1	59·3	62·7	57·6	...
68·7	66·7	63·3	57·7	52·6	48·0	47·8	49·6	54·1	58·1	63·5	66·7	58·1	...

* Either temperature or height is too great.

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
Santiago de Chili,	Chili	5	1868–72	M.T.	−33 27	−70 41	1703
Quinquina, . .	do.	3	1883–86	do.	−36 37	−73 3	189
Talca, . . .	do.	2	1871–72	9 : 9	−35 26	−71 46	344
Valdivia, . .	do.	4	1869–72	do.	−39 49	−73 17	43
Do. . .	do.	15	18 ? –75	6 : 2, 10	−39 49	−73 17	43
Corral, . .	do.	3	1870–72	do.	−39 52	−73 17	105
Ancud, . .	do.	3½	1869–71, '86	M.T.	−41 51	−74 1	134
Puerta Mont, .	do.	4	1869–72	6 : 2, 10	−41 30	−72 57	20
Punta Arenas, .	do.	8	1853–61	M.m.	−53 8	−70 52	33
San Jorge, . .	Uruguay	8	1880–87	do.	−32 43	−56 8	400
Monte Video, .	do.	10	1843–52	S.R. : 2, S.S.	−34 54	−56 13	39
Salta, . . .	Argentine Rep.	7	1873–76, '79–82	7 : 2, 9	−24 46	−65 24	4030
Assuncion, . .	do.	3	1855–57	6, N. : 6, M.	−25 16	−57 40	322
Do. . .	do.	1½	1874–75	9 : 9, M.m.	−25 16	−57 40	322
Villa Formosa, .	do.	4	1879–82	7 : 2, 9	−26 13	−58 10	328
Corrientes, . .	do.	7	1873–80	do.	−27 28	−58 49	280
Goya, . . .	do.	10	1876–86	do.	−29 0	−59 15	209
Tucuman, . .	do.	7	1873–85	do.	−26 51	−65 12	1522
Rioja, . . .	do.	4	1875–78	do.	−29 20	−67 15	1773
Mendosa, . .	do.	6	1875–80	do.	−32 53	−68 49	2641
San Luis, . .	do.	3½	1874–77	do.	−33 19	−66 20	2490
Cordova, . .	do.	4⅓	1872–76	do.	−31 25	−64 11	1460
Concordia, . .	do.	3	1876–78	do.	−31 25	−58 4	200
S. Antonio de Areco,	do.	3	1879–82	do.	−34 13	−59 30	121
Rosario, . .	do.	6	1875–80	do.	−32 57	−60 38	128
Villa Hermandarius,	do.	8	1877–84	do.	−31 15	−59 40	195
Parana, . .	do.	8	1875–82	do.	−31 44	−61 1	256
Buenos Ayres, .	do.	21	1856–76	do.	−34 39	−58 23	12
Do. .	do.	8	1870–77	8 : 8	−34 39	−58 23	50
Tandil, . .	do.	6	1876–82	7 : 2, 9	−37 17	−59 8	650
Bahia Blanca, .	do.	14	1870–83	do.	−38 45	−62 11	49
Carmen, . .	Patagonia	2	1883–85	M.T.	−40 49	−62 48	[0]
Chubut, . .	do.	3¼	1880–83	7 : 2, 9,	−43 18	−65 15	98
Ushuaia, . .	do.	7½	1876–82	7 : 2, 9, 9	−54 53	−68 10	98
Do. . . .	do.	1	1882–83	do.	−54 53	−68 10	98
Cape Pembroke, .	do.	9	1859–68	4, 9 : 3, 8	−51 41	−57 47	[0]
Orange Bay, .	do.	1	1882–83	hourly	−53 31	−70 25	39
South Georgia, .	do.	1	do.	do.	−54 31	−36 5	30
Port Stanley, .	do.	4½	1881–83, '85, '87.	M.m.	−51 42	−57 48	22
North Atlantic,* .		5⅔	1881–86	...	12 30	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .	* Calculated from data published in the United States International Meteorological Observations.	5⅔	do.	...	do.	−32 30	0
Do. .		5⅔	do.	...	do.	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0
Do. .		5⅔	do.	...	do.	−52 30	0
Do. .		5⅔	do.	...	17 30	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .		5⅔	do.	...	do.	−32 30	0

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
68·2	65·3	61·2	53·4	48·4	45·0	44·2	48·2	50·7	56·5	61·9	66·0	55·8	...
67·1	66·7	61·6	59·1	54·5	51·1	49·6	52·0	54·0	58·8	61·6	65·4	58·5	...
70·2	68·2	63·8	55·5	48·4	44·1	43·3	47·5	50·9	58·6	62·1	66·9	56·5	...
59·0	58·5	55·4	49·5	48·0	43·2	43·7	44·1	46·4	51·3	55·0	56·8	50·9	...
61·6	60·8	57·2	52·8	49·6	46·2	45·0	46·2	48·6	52·3	55·9	58·8	52·9	...
57·9	57·5	55·9	51·1	48·4	47·5	45·1	44·4	47·7	50·9	55·2	56·8	51·4	...
56·4	56·7	54·6	51·3	49·0	47·0	46·0	45·8	47·9	50·4	52·3	54·7	51·0	...
57·7	59·0	55·2	51·3	48·9	45·9	45·9	45·7	47·8	51·8	54·5	56·5	51·6	...
51·5	50·4	47·1	42·0	38·8	36·8	34·6	36·0	39·7	43·9	46·8	49·6	43·0	...
73·2	71·4	69·7	59·3	54·0	50·7	48·4	53·9	56·0	59·7	66·0	70·2	61·0	...
73·0	72·1	68·7	64·0	57·6	53·1	51·8	51·6	56·3	61·2	65·5	70·3	62·2	...
71·8	71·1	67·3	62·8	58·5	52·9	53·3	57·9	62·0	66·0	70·2	72·0	63·8	...
85·6	82·5	79·0	72·4	66·4	63·2	64·3	67·3	68·8	76·1	79·8	79·9	73·8	...
82·3	82·2	79·4	72·7	65·4	63·0	64·0	68·5	73·0	78·3	80·1	80·3	74·1	...
80·8	80·4	77·7	70·0	65·5	63·7	63·3	65·8	67·1	73·4	76·1	79·7	72·0	...
79·3	79·5	77·5	71·1	65·3	60·8	61·0	62·8	66·2	70·2	75·0	78·6	70·6	...
77·4	77·0	75·6	66·9	61·0	58·3	58·0	61·3	63·3	67·8	72·1	76·3	67·9	...
77·7	75·2	72·5	67·1	59·4	54·5	54·0	58·8	64·6	69·1	73·6	76·1	66·9	...
81·5	79·0	77·2	66·6	59·2	53·8	56·3	59·4	67·3	73·4	76·6	80·8	69·3	...
73·4	74·2	67·8	58·8	50·2	45·7	46·4	49·6	55·2	62·2	69·6	74·1	60·6	...
76·5	74·1	68·4	59·2	52·5	46·2	48·6	51·8	58·1	64·6	68·0	72·1	61·7	...
73·0	72·2	65·8	60·1	55·7	48·3	50·4	53·5	60·3	63·8	67·6	72·6	61·9	...
76·8	75·2	74·3	64·6	55·9	53·1	54·3	55·8	59·5	63·5	69·1	73·2	64·6	...
73·2	73·9	69·6	60·3	54·1	50·0	48·9	52·3	54·3	60·8	68·5	74·1	61·7	...
74·3	73·8	70·2	62·8	56·3	50·9	52·3	54·0	57·2	62·8	67·8	71·2	62·8	...
78·9	77·4	75·4	65·3	58·6	55·3	55·6	58·3	61·7	67·5	73·1	77·2	67·0	...
75·9	76·7	73·2	64·8	57·9	53·2	55·0	56·7	60·3	65·5	70·9	74·3	65·4	...
75·6	74·3	70·3	62·8	56·5	52·4	50·0	53·6	57·0	62·3	68·6	72·8	63·0	...
75·6	74·8	69·6	63·1	55·7	51·1	50·6	53·1	57·6	62·2	68·9	71·4	63·6	...
70·2	70·0	66·4	58·1	52·5	46·4	46·6	48·9	51·4	56·3	63·3	66·7	58·1	...
73·2	72·1	66·6	57·9	52·0	46·2	46·8	49·3	53·8	59·4	66·9	70·2	59·5	...
70·9	67·3	67·3	53·9	48·1	44·2	44·2	46·3	52·5	60·4	66·3	69·6	57·6	...
70·0	69·8	63·7	53·6	45·5	40·3	42·4	46·2	50·9	58·8	65·0	68·2	56·2	...
52·2	49·6	45·5	42·0	38·5	33·3	30·8	32·4	39·4	42·0	47·6	48·3	42·0	...
49·3	51·6	47·5	41·7	40·5	34·9	37·6	40·3	40·3	41·7	45·5	49·3	43·3	...
49·1	48·6	49·3	43·3	42·3	38·5	37·0	38·7	41·5	43·3	46·2	45·9	43·7	...
46·0	48·0	42·6	40·8	39·9	36·1	37·8	37·4	(42·4)	42·8	44·2	46·2	41·7	...
40·8	42·2	39·2	33·4	31·6	27·3	28·3	34·2	31·6	34·0	37·8	39·9	34·9	...
48·9	49·5	45·8	41·4	39·8	36·0	36·6	37·2	38·6	43·0	46·2	48·0	42·6	...
76·6	75·9	76·6	77·3	78·1	79·2	79·8	80·5	81·4	81·7	81·0	79·1	78·9	...
76·7	76·2	76·3	77·3	77·7	78·9	79·7	80·9	82·1	81·7	80·9	78·3	78·9	...
76·7	76·8	76·9	77·8	78·1	79·0	79·9	81·2	82·6	81·7	80·4	78·4	79·1	...
77·0	77·0	77·1	77·8	78·5	78·8	80·1	81·7	82·6	81·9	80·9	78·8	79·4	...
77·4	77·3	77·5	78·1	78·8	79·3	80·4	82·5	83·3	82·4	80·3	78·9	79·7	...
77·6	77·3	77·5	78·3	79·1	79·5	80·7	83·1	83·5	82·4	80·4	78·5	79·8	...
78·2	77·8	77·8	78·7	79·3	80·0	81·1	83·2	83·7	82·7	80·6	78·7	80·1	...
73·3	72·8	73·2	74·5	74·5	77·3	78·7	79·4	80·0	79·8	78·9	76·0	76·5	...
73·6	73·2	73·4	74·5	75·1	77·0	78·6	80·0	80·7	80·2	78·9	75·9	76·8	...
72·5	73·6	74·3	74·9	75·9	77·5	78·8	80·3	81·1	80·1	78·3	76·2	77·0	...

Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
North Atlantic *	* Calculated from data published in the United States International Meteorological Observations.	5⅔	1881–86	...	17 30	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0
Do. .		5⅔	do.	...	do.	−52 30	0
Do. .		5⅔	do.	...	do.	−57 30	0
Do. .		5⅔	do.	...	22 30	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .		5⅔	do.	...	do.	−32 30	0
Do. .		5⅔	do.	...	do.	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0
Do. .		5⅔	do.	...	do.	−52 30	0
Do. .		5⅔	do.	...	do.	−57 30	0
Do. .		5⅔	do.	...	do.	−62 30	0
Do. .		5⅔	do.	...	do.	−67 30	0
Do. .		5⅔	do.	...	do.	−72 30	0
Do. .		5⅔	do.	...	27 30	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .		5⅔	do.	...	do.	−32 30	0
Do. .		5⅔	do.	...	do.	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0
Do. .		5⅔	do.	...	do.	−52 30	0
Do. .		5⅔	do.	...	do.	−57 30	0
Do. .		5⅔	do.	...	do.	−62 30	0
Do. .		5⅔	do.	...	do.	−67 30	0
Do. .		5⅔	do.	...	do.	−72 30	0
Do. .		5⅔	do.	...	do.	−77 30	0
Do. .		5⅔	do.	...	32 30	−12 30	0
Do. .		5⅔	do.	...	do.	−17 30	0
Do. .		5⅔	do.	...	do.	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .		5⅔	do.	...	do.	−32 30	0
Do. .		5⅔	do.	...	do.	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0
Do. .		5⅔	do.	...	do.	−52 30	0
Do. .		5⅔	do.	...	do.	−57 30	0
Do. .		5⅔	do.	...	do.	−62 30	0
Do. .		5⅔	do.	...	do.	−67 30	0
Do. .		5⅔	do.	...	do.	−72 30	0
Do. .		5⅔	do.	...	do.	−77 30	0
Do. .		5⅔	do.	...	37 30	−12 30	0
Do. .		5⅔	do.	...	do.	−17 30	0
Do. .		5⅔	do.	...	do.	−22 30	0
Do. .		5⅔	do.	...	do.	−27 30	0
Do. .		5⅔	do.	...	do.	−32 30	0
Do. .		5⅔	do.	...	do.	−37 30	0
Do. .		5⅔	do.	...	do.	−42 30	0
Do. .		5⅔	do.	...	do.	−47 30	0

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
74·2	74·6	74·5	75·1	76·4	77·6	79·2	80·9	81·6	80·3	78·1	76·4	77·4	...
74·5	74·9	75·1	75·7	77·5	78·2	79·7	81·8	82·0	80·8	78·3	76·2	77·9	...
74·8	75·1	75·3	75·9	77·5	78·8	80·6	82·6	82·3	81·0	78·8	76·5	78·3	...
75·7	75·4	75·8	77·2	78·2	80·0	81·1	83·0	82·7	81·4	79·6	76·6	78·9	...
76·8	76·4	76·8	78·7	80·5	81·3	82·3	83·6	83·0	81·7	79·4	78·3	79·9	...
70·3	69·7	69·8	71·5	72·4	74·8	76·9	77·8	78·4	77·6	75·7	73·3	74·0	...
70·6	70·4	70·3	71·7	72·5	75·1	77·3	78·6	79·0	78·0	75·9	73·2	74·4	...
71·3	71·4	71·0	72·3	73·6	75·7	77·9	79·2	79·8	78·3	76·1	73·5	75·0	...
72·0	72·1	71·8	72·1	74·3	76·0	78·5	80·1	80·5	78·8	76·3	74·2	75·6	...
72·2	72·5	72·1	73·3	74·9	76·9	79·2	81·2	81·0	78·8	76·6	74·2	76·1	...
72·5	72·7	72·5	73·5	75·7	77·7	80·0	82·0	81·1	79·3	76·8	74·6	76·5	...
72·8	72·9	72·8	75·0	76·6	78·9	80·8	82·7	81·4	79·7	77·5	75·0	77·2	...
73·0	73·2	73·1	75·1	77·7	79·6	81·6	83·0	82·0	80·1	78·0	75·3	77·6	...
73·5	73·3	73·3	75·5	78·0	80·2	82·0	82·7	82·2	80·2	78·2	75·3	77·9	...
73·7	73·5	73·4	75·7	78·3	80·9	82·5	82·5	82·2	80·1	77·9	75·1	78·0	...
73·4	73·5	74·1	75·3	79·3	82·1	83·4	83·1	83·0	80·6	77·4	74·5	78·3	...
67·0	66·2	66·8	68·6	69·8	72·8	75·7	76·6	76·7	74·7	72·5	68·9	71·4	...
67·5	67·4	67·5	69·2	70·6	73·6	76·0	77·4	76·9	75·3	72·4	69·8	72·0	...
68·1	68·0	68·1	69·6	71·4	74·1	76·7	78·3	77·7	75·6	72·9	70·4	72·6	...
68·8	68·5	68·3	70·0	72·0	74·6	77·7	79·4	78·5	76·0	73·5	71·1	73·2	...
68·9	68·7	68·6	70·3	72·3	74·8	78·3	80·4	78·9	76·1	73·2	71·3	73·5	...
69·5	68·7	68·8	70·7	72·9	75·4	79·0	80·9	79·2	76·4	73·8	71·7	73·9	...
69·6	69·1	69·0	70·6	73·9	76·5	79·7	81·5	79·8	76·7	74·3	72·2	74·4	...
70·1	69·0	69·1	71·4	74·1	77·5	80·2	81·7	80·0	77·1	74·4	71·6	74·7	...
69·7	69·1	69·0	71·7	74·2	78·2	81·0	81·8	80·7	77·3	74·4	70·7	74·8	...
69·9	69·4	68·9	72·0	74·8	78·9	81·4	82·1	81·1	77·5	75·1	71·1	75·2	...
69·0	69·0	69·2	71·8	75·9	80·0	82·0	82·2	81·5	77·7	73·3	70·7	75·2	...
65·7	65·8	67·4	71·7	76·7	81·2	83·1	82·7	80·9	76·3	70·9	67·1	74·1	...
62·8	62·4	63·0	64·6	67·7	70·6	73·6	75·7	74·1	71·2	68·0	62·8	68·0	...
63·2	62·5	63·0	64·6	66·9	70·0	73·0	74·8	74·2	71·4	67·5	64·3	68·0	...
63·9	63·4	63·7	65·1	67·2	70·7	73·9	76·2	74·5	72·6	68·5	65·9	68·8	...
64·3	63·9	64·2	66·1	67·8	71·7	75·0	76·5	75·1	72·9	69·0	66·8	69·4	...
64·4	64·2	64·8	66·4	68·4	72·1	75·4	77·6	76·0	73·4	69·6	67·1	70·0	...
64·2	64·3	64·4	66·4	68·8	73·0	75·9	78·5	76·6	73·4	70·1	67·6	70·3	...
64·2	63·8	64·2	65·9	69·0	72·8	76·6	79·1	77·0	73·7	70·2	67·5	70·3	...
64·7	63·2	63·7	65·6	69·2	73·0	76·9	79·6	77·1	73·1	70·6	67·5	70·4	...
64·4	63·2	63·6	65·8	69·4	74·0	77·4	79·9	77·5	73·2	70·7	67·2	70·5	...
64·4	62·9	62·4	66·2	70·2	74·4	78·7	80·0	77·9	73·1	70·5	66·3	70·6	...
63·2	62·7	61·7	66·4	70·5	75·1	78·8	79·8	78·4	73·4	69·9	66·4	70·5	...
62·3	61·5	61·3	65·8	70·7	76·2	79·4	80·1	78·5	73·3	68·9	65·2	70·3	...
59·8	59·4	60·3	64·8	70·3	75·9	79·6	80·2	78·5	72·7	67·1	63·3	69·3	...
50·7	53·2	54·6	61·8	69·7	76·2	79·5	78·4	75·2	67·7	58·4	53·9	64·9	...
57·2	57·7	59·3	61·1	64·4	68·0	71·9	73·7	70·4	66·5	62·7	57·3	64·2	...
59·3	58·7	59·9	61·4	63·9	67·3	70·6	72·6	70·6	67·8	63·9	60·3	64·7	...
60·1	59·3	60·0	62·1	64·2	68·9	72·2	73·5	71·0	68·9	64·8	61·4	65·5	...
60·2	59·6	60·7	62·6	64·4	69·3	73·1	74·3	71·7	69·4	64·2	61·8	65·9	...
60·0	59·6	60·5	62·6	64·4	69·5	73·2	74·8	72·7	69·7	64·9	62·4	66·2	...
59·3	58·7	60·2	62·1	65·4	69·8	73·3	75·4	72·7	69·6	64·5	62·4	66·1	...
58·4	57·1	58·8	61·1	63·9	69·6	73·0	75·6	72·3	69·2	63·2	61·1	65·3	...
56·8	55·6	57·0	59·4	63·4	69·0	72·7	75·7	72·0	68·4	63·5	59·9	64·5	...

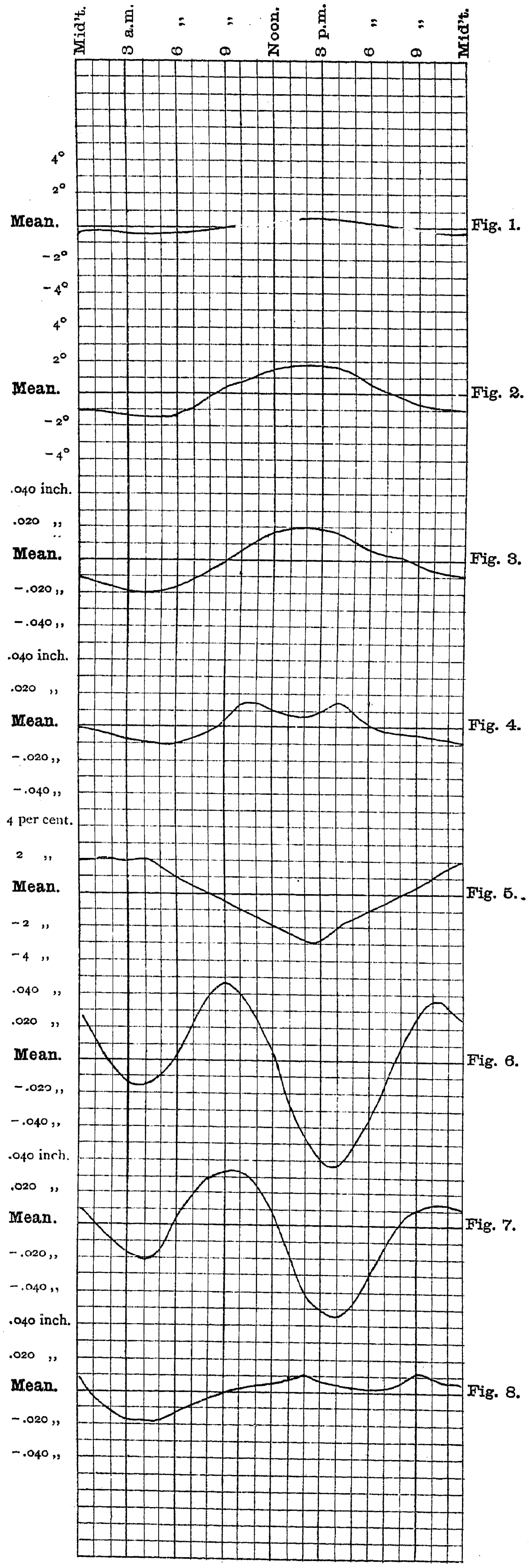
Stations.	Country.	No. of Years.	Years Specified.	Hours of Observation.	Latitude.	Longitude.	Height, Feet.
					° ′	° ′	
North Atlantic,*		$5\frac{2}{3}$	1881–86	...	37 30	−52 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−57 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−62 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−67 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−72 30	0
Do. .		$5\frac{2}{3}$	do.	...	42 30	−12 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−17 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−22 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−27 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−32 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−37 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−42 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−47 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−52 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−57 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−62 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−67 30	0
Do. .		$5\frac{2}{3}$	do.	...	47 30	−12 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−17 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−22 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−27 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−32 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−37 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−42 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−47 30	0
Do. .		$5\frac{2}{3}$	do.	...	52 30	−12 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−17 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−22 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−27 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−32 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−37 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−42 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−47 30	0
Do. .		$5\frac{2}{3}$	do.	...	57 30	−12 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−17 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−22 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−27 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−32 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−37 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−42 30	0
Do. .		$5\frac{2}{3}$	do.	...	do.	−47 30	0

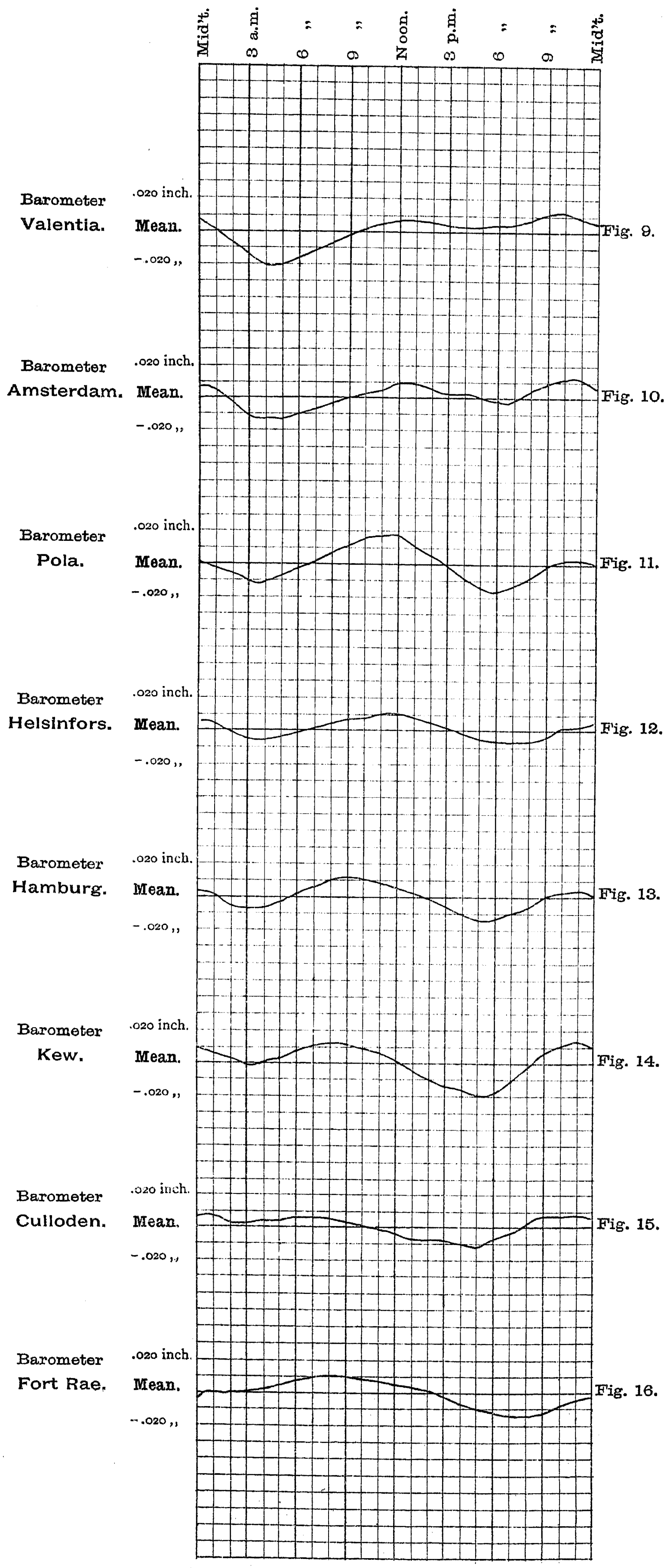
* Calculated from data published in the United States International Meteorological Observations.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Corrs. Applied.
°	°	°	°	°	°	°	°	°	°	°	°	°	°
55·9	54·4	55·7	59·0	63·5	69·9	73·4	75·9	72·0	68·0	63·4	59·0	64·2	...
55·1	53·2	54·6	58·9	64·0	70·4	73·8	76·0	72·4	67·5	62·7	57·7	63·9	...
53·0	51·9	52·4	57·7	63·4	69·8	73·6	75·3	72·3	66·8	61·0	55·9	62·8	...
50·2	48·8	49·6	56·3	62·4	68·8	73·4	74·3	71·7	65·3	59·1	53·4	61·1	...
42·8	43·4	45·3	52·2	60·8	68·5	74·0	73·5	70·6	63·4	53·8	47·4	58·0	...
53·8	54·9	56·8	57·5	61·7	65·8	70·3	71·0	67·4	62·8	59·5	54·7	61·4	...
55·7	55·7	56·7	57·4	60·7	64·6	69·0	69·6	66·9	63·8	60·3	57·0	61·5	...
56·2	55·6	56·7	58·4	60·7	65·1	68·3	70·3	67·6	65·4	60·4	57·3	61·8	...
55·9	55·1	56·8	58·6	60·8	65·2	69·1	70·6	67·8	64·9	59·8	58·0	61·9	...
55·2	54·3	56·4	58·5	60·5	65·3	69·4	70·8	68·1	65·0	59·3	57·8	61·7	...
53·2	52·0	55·1	57·8	59·2	65·2	69·1	70·7	68·0	64·0	58·6	56·8	60·8	...
50·2	48·3	52·3	55·3	58·1	64·6	69·4	70·2	67·1	62·7	56·8	54·0	59·1	...
45·4	42·4	46·6	49·6	54·2	61·6	66·7	67·7	65·5	59·7	53·8	49·5	55·2	...
42·4	39·4	43·1	46·8	52·1	61·3	66·6	68·6	64·9	58·6	52·2	47·1	53·6	...
39·6	36·3	41·2	46·5	53·3	62·0	67·6	69·3	64·6	57·7	51·2	45·0	52·9	...
35·3	33·9	37·0	43·8	51·6	61·0	66·1	67·9	63·1	55·2	48·7	41·6	50·4	...
29·4	30·0	33·0	41·7	49·9	58·6	63·7	65·2	61·1	52·3	44·5	36·5	47·2	...
51·3	51·6	52·8	54·1	57·3	61·3	64·4	65·6	62·2	58·4	55·2	52·3	57·2	...
52·0	51·8	52·7	54·1	56·7	60·7	63·0	64·7	61·8	58·9	55·4	53·4	57·1	...
51·9	50·3	52·4	54·1	56·0	60·2	62·8	64·4	61·8	58·9	54·8	53·2	56·7	...
50·7	49·9	51·6	53·7	55·8	60·1	62·7	63·9	61·0	58·6	54·0	52·5	56·2	...
49·1	48·4	50·6	52·9	55·3	60·4	62·8	64·3	61·1	57·5	53·1	51·4	55·6	...
46·1	45·3	48·9	51·6	54·3	58·9	62·4	63·6	60·2	56·5	50·9	49·6	54·0	...
40·3	39·6	44·0	48·1	50·8	56·3	60·0	61·0	57·9	52·5	47·2	43·7	50·1	...
33·1	31·8	36·3	41·8	45·8	51·7	56·7	58·1	54·9	48·5	41·9	36·9	44·8	...
46·3	47·6	48·3	50·9	54·2	58·2	60·0	60·6	58·3	54·7	50·5	47·4	53·1	...
47·2	47·0	48·3	51·0	52·7	56·9	59·2	59·7	57·4	54·2	50·8	48·4	52·7	...
46·4	45·7	47·4	49·7	51·5	56·1	58·7	59·1	56·7	53·4	50·1	48·0	51·9	...
44·4	43·8	45·9	48·9	50·7	55·0	57·5	58·3	55·9	52·6	48·5	46·5	50·7	...
41·9	41·7	44·4	47·5	49·8	53·5	56·6	57·6	55·2	51·3	46·6	44·5	49·3	...
38·5	38·0	42·4	45·1	48·5	52·0	55·7	56·8	53·8	49·5	44·3	41·8	47·2	...
33·4	33·0	37·4	41·5	45·9	50·4	53·8	55·0	53·0	46·7	41·2	37·7	44·1	...
27·3	26·4	30·2	37·9	42·3	48·1	51·3	52·6	49·5	43·1	36·8	32·0	39·8	...
42·1	42·1	43·1	46·3	49·4	53·9	56·2	56·0	54·1	49·0	44·7	42·2	48·3	...
41·2	40·6	41·5	45·3	48·2	52·6	54·9	55·0	53·0	48·4	43·9	41·4	47·2	...
39·7	38·8	39·9	44·0	46·8	51·2	53·2	54·0	51·6	47·2	42·7	40·3	45·8	...
36·9	36·6	38·5	42·9	45·4	50·1	52·3	52·9	50·4	45·6	41·1	38·8	44·3	...
33·7	33·7	36·3	41·5	43·9	48·9	50·9	51·7	49·2	43·4	39·0	36·5	42·4	...
31·1	30·6	33·1	38·9	42·6	47·6	49·9	50·4	47·1	41·8	36·6	34·6	40·4	...
27·5	27·3	30·5	36·0	40·8	46·5	48·9	49·3	46·0	40·1	34·4	30·7	38·2	...
22·7	22·8	26·7	34·0	39·2	45·0	48·4	47·7	44·3	38·0	30·7	26·9	35·5	...

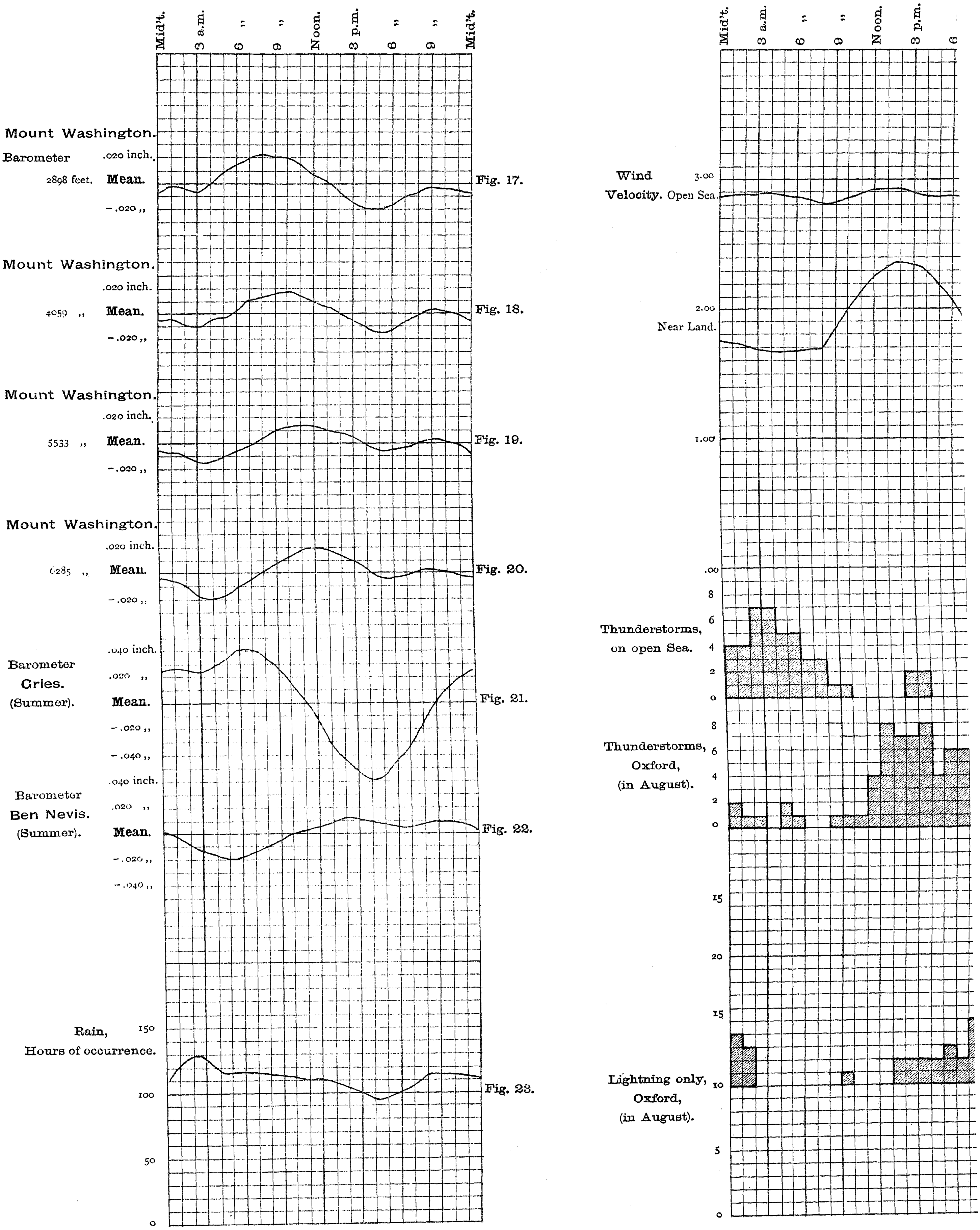
INDEX TO APPENDICES.

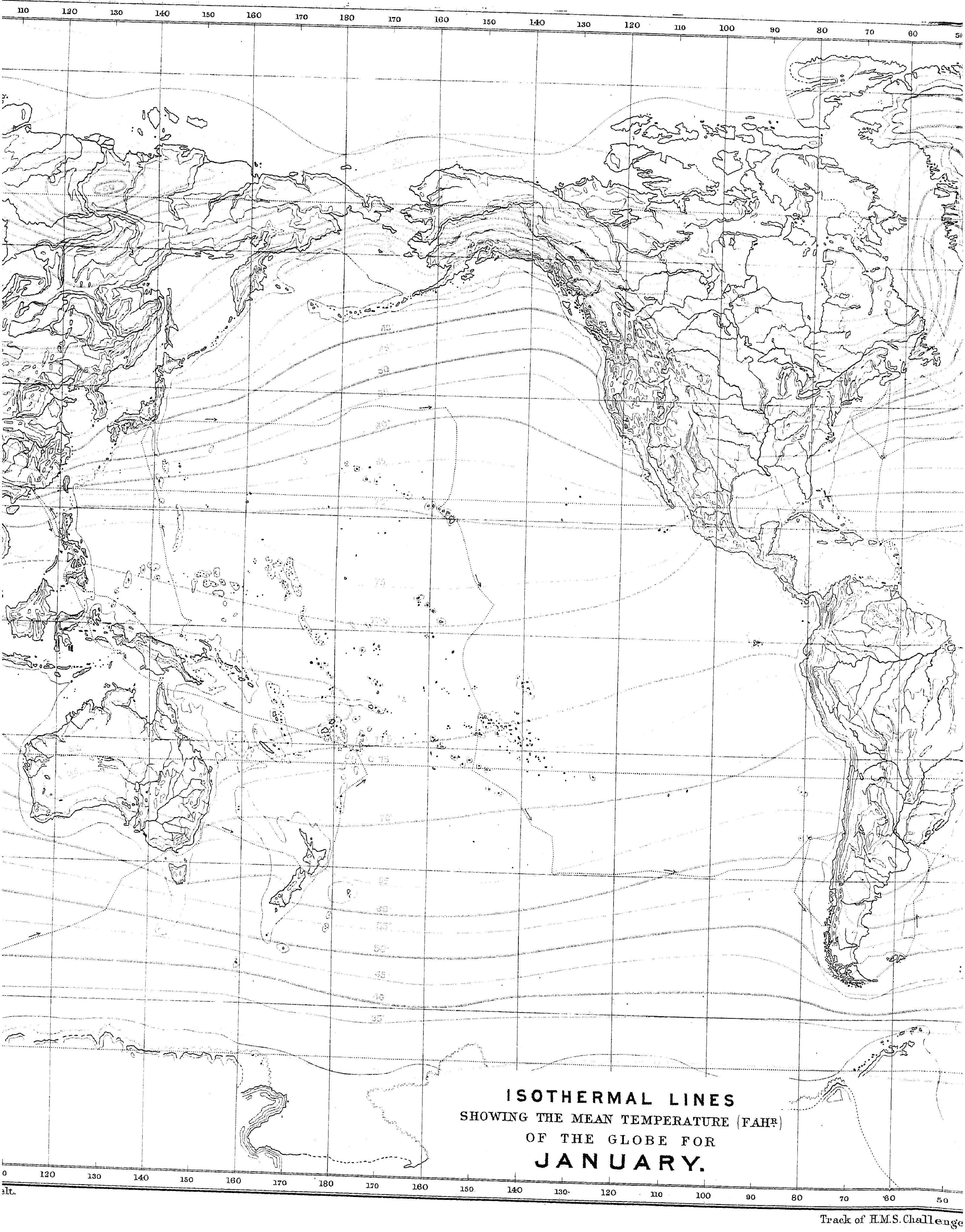
Curves showing Deviations at Different Hours of the Day, from the Mean Daily Temperature and Pressure.





Curves showing Deviations at Different Hours of the Day, from the Mean Daily Pressure, Wind Velocity, &c.





Track of H.M.S. Challenge

shown thus ....

John Bartholomew & Co.

THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on the MAGNETICAL RESULTS obtained by H.M.S. Challenger during the years 1873–1876. By Staff-Commander E. W. CREAK, R.N., F.R.S.

SINCE the year 1700, when Halley published his map of equal curves of magnetic declination for the Atlantic and Indian Oceans, that method of representing the values of the magnetic elements for frequent reference seems to have found general favour, probably from the facility with which the information they contain can be utilised. Thus since Halley's day the following authors have published maps of the declination :—Mountaine and Dodson in 1756, Churchman in 1794, Yeates in 1817, and Barlow in 1833.

Again, in 1819, Hansteen[1] added maps of the inclination to those of the declination for different epochs between the years 1600 and 1787, and although the angular direction of the freely suspended needle was thus known for a considerable portion of the earth's surface, it was not until the present century that the intensity of the earth's directive force was observed and known as well as the other elements. In the year 1826 he published a chart of "Isodynamic Lines," which he revised in 1832, both editions being based partly upon his own observations, combined with those from other available sources.

Following Hansteen there appeared in 1840 Gauss and Weber's Atlas, the result of calculation from about eighty-four observations distributed over the world. Considering the comparatively slender basis of observation upon which they had to rely for the application of their mathematical investigations, it is remarkable, even when regarding their work in the light of the results of the present activity amongst magnetic observers, how nearly they approached the truth. It may be added that, in view of the extended knowledge now possessed of the distribution of the earth's magnetism, there remains

[1] *Magnetismus der Erde.*

but one obstacle to a re-calculation of the Gaussian constants promising important results—the necessity for a fresh magnetic survey of the regions south of the parallel of 40°. The observations made by the memorable Antarctic Expedition under Ross in 1839–43 were of immense importance when taken in connection with those made in other portions of the world about the same date, and at different epochs where the secular change was known; but enough has since been ascertained to show that considerable changes have been going on in Antarctic regions, and until these changes are accurately known by means of extended observation the data for calculation must remain imperfect.

In 1868 Sir Edward Sabine read No. XI. of his "Contributions to Magnetism" before the Royal Society, being the first of four papers on the Magnetic Survey of the Globe for the epoch 1842–45, the last of these being read in June 1876, just as the Challenger had completed her voyage. As Sabine's maps accompanying these contributions serve as a point of departure with which subsequent maps may be compared, it seems proper to recall here some of the details of the observations upon which they were founded.

From all that is now known of the secular change of the magnetic elements, the mean epoch 1842–45 was wisely chosen by Sabine for his magnetic survey. As already remarked, it was about this time that the magnetic survey of the Antarctic region was undertaken by Ross, and others subsequently completed much that he was unable to do, and therefore the question of correction for secular change might, without serious error, be neglected for that part of the world. But in the Arctic regions and temperate zones observations had been so multiplied for different epochs that those made several years before and after the mean epoch could be reduced thereto by the known secular change, and therefore utilized. A glance at Sabine's maps shows that for Europe he was well supplied with data for his lines of equal value, in North and South America and some parts of Asia fairly so, whilst Africa presents almost a blank as regards inclination and intensity, although the collected observations range over the years 1818–71. These lines give normal values; for Sabine, knowing full well the uncertain distribution of local magnetic disturbance on land, always placed a high value on sea observations. He found observers had done ample work for the North and South Atlantic Oceans, and in a less degree in other seas except the North and South Pacific Oceans, for which his maps are almost blank, the lines being only given for certain parts.

One object in recalling these facts is to show that, valuable as is Sabine's Magnetic Survey of the Globe as the first of its kind in which the intensity is included for so large a portion of its navigable seas as well as the land, the whole forming a standard of comparison for succeeding surveys, there remained a large field for observations in parts of the world hitherto unvisited for magnetic purposes; and further, to show how the Challenger Expedition not only filled up these gaps but added largely to our

knowledge of the changes going on in the magnetic elements in the regions of previous observation.

In presenting the accompanying charts of the magnetic elements for 1880, numbered I. to IV., it is thought that they will not only be acceptable to magneticians as showing the distribution of magnetic force and direction for that year, but, when compared with Sabine's, to indicate the general tendency of the secular change for the previous forty years. But before comparing these later charts with their predecessors, and before their value or otherwise can be duly determined, it seems necessary that the various steps in their construction should be given in detail. Let the large share of data contributed by the Challenger be first considered.

An ideal vessel for carrying out a magnetic survey at sea is one in which there is no iron used in her construction, or at least with the iron so distributed as to have little or no effect at the position of the magnetical instruments used for the observations, and further that she should be an easy vessel at sea under ordinary circumstances.

The Challenger can hardly be said to have come up to this ideal in either respect, for she was seldom at rest from pitching or rolling motion at sea, and although north of the magnetic equator the errors of the compass and Fox dip and intensity apparatus were moderate and could be eliminated by occasional "swinging" of the ship, the errors caused by the vertical component of her magnetism were large, and, although quite manageable, necessitated a frequent comparison with normal values on land. This magnetic condition of the ship was not without its compensation, for south of the magnetic equator the hard and soft iron which had previously combined to produce errors in the observed values of the magnetic elements, had now opposite signs, and when near the Antarctic circle and far from a point of comparison on land, had but small effect.

It may be urged that the differences observed between the results on board the ship and those on land might not be a true measure of the effects of the iron of the ship on account of possible local magnetic disturbance at the land station selected. In some places this was no doubt true, but from a lengthened discussion of observations made in numerous places in both hemispheres, where no traces of such disturbance could be found, the magnetic condition of the ship could be ascertained at any period of the voyage. This knowledge was not only fruitful as a means of reducing the observations made at sea to normal values, but during the visits of the vessel to the neighbourhood of places either known to be or suspected of being affected by local magnetic disturbance, the amount of such disturbance could be measured with considerable accuracy.

Local magnetic disturbance in the solitary islands of the great oceans was especially open to this method of detection, for the vessel could be brought sufficiently near them to avoid errors due to difference of geographical position, and yet in sufficiently deep water to be free from magnetic effects in the land. To illustrate this, some results

obtained in the neighbourhood of the more important islands visited by the Challenger may be enumerated.

Madeira and *Tenerife* were the first islands visited in the Atlantic, and the differences between the observations on their shores and the normal results on board were of a nature to invite closer inquiry in other islands as time permitted. Thus at Madeira observations of the inclination were made at a distance of one foot and $3\frac{1}{4}$ feet from the ground, with a difference of $7\frac{1}{2}°$ in the result; whilst at Santa Cruz, Tenerife, the inclination was $2\frac{1}{2}°$ in excess of the normal on board the ship.

Bermuda.—Here the local disturbance was such as to invite particular examination, especially as during the two visits of the Challenger time permitted many observations to be made. Previously to these visits observers in positions at short distances apart differed considerably in their results. Our men-of-war, too, in the process of swinging for the deviation of their compasses at the different anchorages, noticed constant errors for all directions of the ship's head, which were confined to Bermuda alone, and evidently proceeded from some local magnetic disturbance, the character of which required to be definitely examined by means of instruments with which they were unprovided. This was therefore an opportunity for doing immediate practical service whilst instituting scientific inquiry by means of the excellent equipment of instruments furnished to the Challenger both for absolute and relative determinations.

With these objects in view, the declination was observed at seventeen stations on land, the inclination at ten, and the intensity at seven. The ship was swung at sea 15′ south of the green outside the dockyard, and normal values of the three magnetic elements for the green deduced therefrom. Comparing the observed values with their respective normals, it was found that the greatest differences in the declination were $+2° 39'$ at Clarence Cove, and $-3° 5'$ at Barge Island; in the inclination, $+1° 47'$ at Spanish Point and Mount Langton, and in vertical force at Spanish Point, $+0{\cdot}314$ (British Units). Combining the observations taken in the western portion of the group with eleven others of declination taken at different stations in previous years, plotting the differences from the normal on a chart and drawing curves of equal value, as shown on Plate I., it was found that between the Governor's House at Mount Langton and the lighthouse on Gibb's Hill, there is a disturbing magnetic focus attracting the north-seeking end of the needle with a force considerably in excess of that due to the position of Bermuda on the earth considered as a magnet.

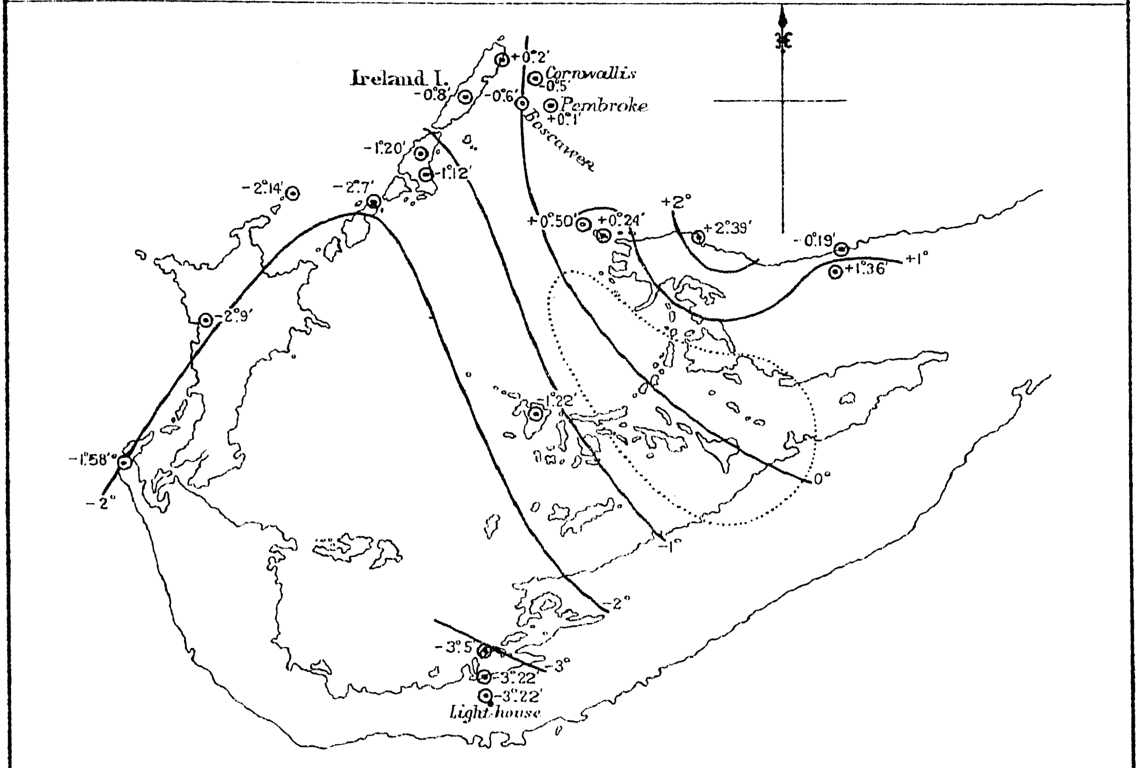
Magnetic disturbance was also found at three other stations in the eastern parts of this group of islands, but the observations made were too few in number to determine any distinct source for it. It is satisfactory, however, to be able to point out to vessels visiting the usual anchorage in Grassy Bay that there is little or no disturbance, whilst at two positions half a mile on either side of it there may be as much as 2° difference in the observed magnetic bearing of an object the true bearing of which is common to

No. 1.

Bermuda Islands.—Western Portion.

Declination. { *The Figures in this plan are observed differences from the normal.*
The dotted line shows assumed position of magnetic focus.

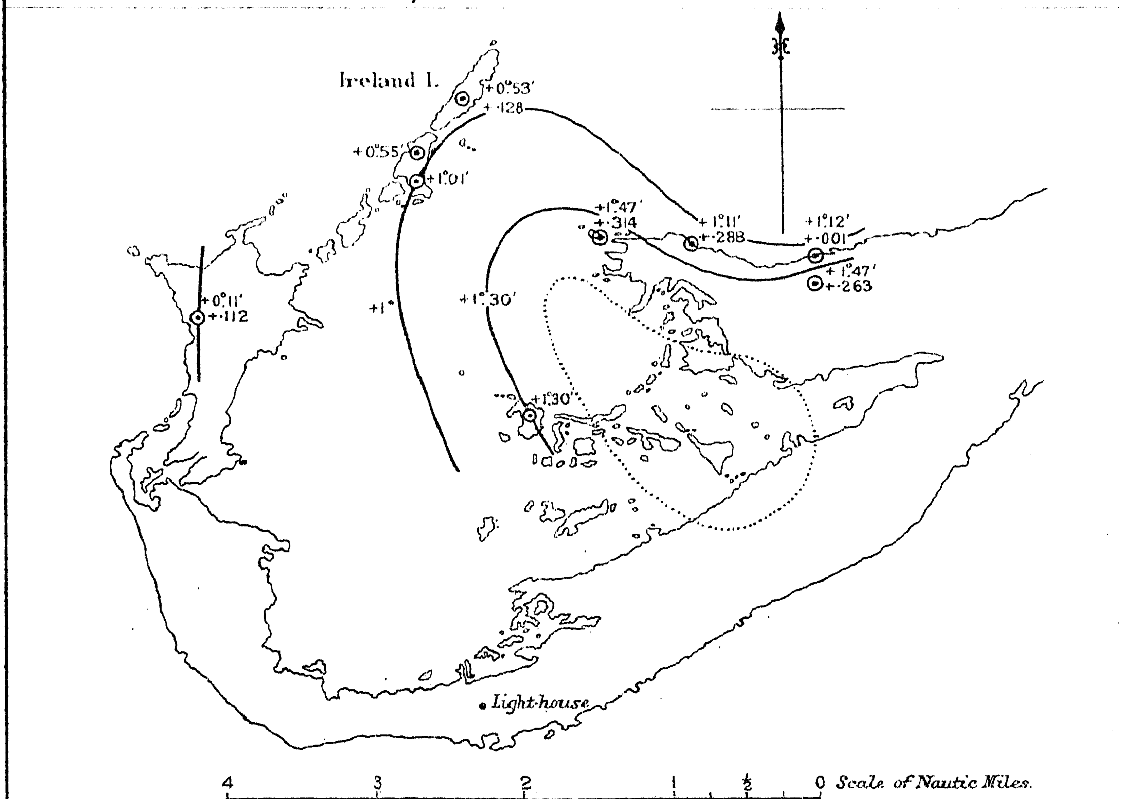
The black curves denote equal values of disturbance in the Declination.



No. 2.

Inclination
Vertical Force. { *The Figures in the plan are observed differences from the normal.*
The dotted line shows assumed position of magnetic focus

The black curves denote equal values of disturbance in the Inclination.



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both. It is not intended to enter into any further discussion of these Bermuda results until those obtained at other islands have been considered.

Taking the other islands in the order visited, they are as follows :—

St. Vincent, Cape Verde Islands.—Here the declination on the west side of the island was 3° in defect of the normal, but the inclination and force were but little affected.

St. Paul's Rocks.—There was little or no disturbance.

Tristan da Cunha.—The westerly declination on the west side of some high cliffs was increased $1\frac{3}{4}°$.

Kerguelen Island.—At Christmas Harbour, Accessible Bay, and Betsy Cove the declination was 1° above the normal, there being high land to the westward of all three stations, and at two positions where the inclination and intensity were observed they were in excess of the normal, all three elements showing marked effects of a force repelling the north-seeking end of the needle.

Sandwich Islands.—At Honolulu, on the west side of some high land in the island of Oahu, the easterly declination was $\frac{3}{4}°$ in excess of the normal value, whilst at Hilo, on the east side of the island of Hawaii, it was $\frac{3}{4}°$ in defect. It has been reported by a careful navigator of one of our vessels of war, that, sailing in the neighbourhood of the islands, he obtained anomalous results of the declination, attributing them to the effects of the visible land. Reasons will hereafter be given for believing in this report as regards the disturbance of the compass, whilst giving other reasons for the cause.

Juan Fernandez.—The declination was not observed here, but, like Kerguelen Island, the inclination and force were affected by a magnetic force repelling the north-seeking end of the needle.

Ascension.—On the coast at Georgetown the observations showed but little local disturbance, whilst at the Green Mountain Station the inclination exceeded the normal by $2\frac{1}{3}°$, the total force by 0·12 (B.U.).

Applying the same test of obtaining normal values of the magnetic elements at sea, and comparing those observed on adjacent islands or other solitary mountains standing out of the sea, such as St. Helena, similar effects result, and the following general conclusions seem to be supported by the facts enumerated with regard to local magnetic disturbance :—

(1) That in islands north of the magnetic equator the north-seeking end of the needle is generally attracted vertically downwards, and horizontally towards the higher parts of the land.

(2) South of the magnetic equator the opposite effects are observed, the north-seeking end of the needle being repelled. In both cases by an amount above that due to the position of the island on the earth considered as a magnet.

But beyond any points of interest to science which may be drawn from these

conclusions, there is another aspect of them which is of great importance to practical navigation. It has been frequently reported that vessels navigating the coasts of certain islands, as well as the mainland, have found their compasses disturbed, such disturbance being imputed to the effects of the visible land. The desirability of either confirming or refuting this impression on the part of seamen by reliable investigation can hardly fail to be appreciated.

It has been shown, with instruments placed on land within five feet of the soil, that the effect of the local magnetic disturbance in localities visited by the Challenger did not exceed at the most more than 2° or 3° in the declination, and $2\frac{1}{2}°$ in the inclination; then, remembering the law of magnetic attraction and repulsion, it is impossible that a vessel's compass in such case could be affected at the ordinary distances of such vessel's passing a coast.

The question, however, is not finally answered by any means by these results, reassuring as they are as far as they go. Thus, near a station on the summit of the bluff,—Bluff Harbour, in the south island of New Zealand,—an observer found the declination to be as follows: when 30 feet north of it, 9° 36′ W., and 30 feet east of it, 46° 44′ E. Now supposing the bluff to be submerged some 30 or 40 feet at three miles from the coast, it is not difficult to conceive that a vessel passing near the spot would find her compass considerably disturbed. In point of fact, there is a remarkable instance, among others, of magnetic disturbance proceeding from submerged magnetic land, namely, at Cossack in North Australia. Here H.M. surveying vessel "Meda," when sailing on the line of transit of two objects on the land, in 8 fathoms of water and three miles from the nearest visible land, suddenly observed a deflection of the standard compass amounting to 30°. This remarkable deflection of the needle remained constant for a quarter of an hour, just time enough for the vessel to sail over about a mile in one direction, when immediately after the compass returned to the original point. Bearings of points of land were taken to confirm these results, as previously to this occasion the anomalous behaviour of the compass in the "Meda," and other vessels navigating in the vicinity, had been noticed.

The question, therefore, with regard to local magnetic disturbance of the compass in ships sailing in the neighbourhood of the land stands thus. That such disturbance undoubtedly exists, that the number of positions where its presence has been proved are comparatively few; but that it behoves the navigator to be on his guard for such a formidable danger, and, when found, to report all particulars as he would that of a newly-found rock or shoal.

Before leaving this part of the subject, it may be remarked that the lines of equal value on the accompanying magnetic charts are normal, the disturbances from local effects being confined to such limits as to be too small to be accurately drawn.

Large as was the Challenger's contribution to these magnetic charts, it will be

readily understood that it required considerable reinforcement from other sources before they could be efficiently constructed, especially as they are dependent upon observation alone. For this purpose every available observation chiefly obtained between the years 1865–87 has been utilised, a large number being furnished by our vessels of war, as well as many others from foreign publications. It is presumed that magneticians are already sufficiently acquainted with the published sources of information on this subject as not to require any special mention of them, but there are others the enumeration of which may tend to add value to the charts. Thus, in the years 1874–76, a series of observations of the inclination and force were made on the east coast of Africa by the officers of H.M.S. "Nassau" with a Fox circle, and in 1885-86 a valuable series, comprising all three elements, was obtained with absolute instruments at certain stations on the west coast of Australia, from Cape Leeuwin to Cossack inclusive, by H.M. surveying vessel "Meda."

That wild waste of waters, too, traversed by ships making their voyages from Australia and New Zealand to Magellan Strait or Cape Horn, has not been neglected. Observations of the declination made in H.M.S. "Esk" in 1867, and "Pearl," 1871—both being wooden ships—and lately, in 1885–86, in the New Zealand Steam Shipping Company's iron ships, have added considerably to our knowledge of its distribution in those seas. The results from the iron ships have been confirmed by those from H.M.S. "Thalia," in 1887, a wooden vessel with but small errors affecting the compass.

To combine this twenty years' observations usefully, a somewhat extended knowledge of the distribution and amount of secular change became a necessity. For certain portions of the earth largely frequented this element of terrestrial magnetism has been approximately determined—at fixed observatories with considerable precision; and, generally speaking, it is only there that its exact and variable value can be obtained, for, as already shown, a distance of a few feet between two observers is quite enough to considerably affect their results.

Amongst other contributions to our knowledge of the secular change may be mentioned those by Mr. C. A. Schott for the United States and Canada, and a few other stations in Europe. This valuable series, which is the outcome of considerable research, is treated both mathematically and graphically, and may be considered as authoritative for North America as regards the secular change of the declination.

The work carried out during the Voyage of the Challenger was of too world-wide a character for any extended magnetic survey of the countries visited, such as that of the United States, one great object being to visit certain positions in unfrequented and widely different parts of the earth where previous observers had been, rather than the beaten tracks. During the outward part of the voyage in 1873, St. Paul's Rocks, in the Atlantic, were visited, and Ross's position when he landed in 1840 occupied as nearly as possible. The position being apparently free from local magnetic disturbance, the

secular change of the elements deduced from the observations made after this interval of thirty-three years may be considered as approximately correct.

Then Tristan da Cunha. Since H.M.S. "Herald" touched at this island in 1852, and observed the declination, no British observer seems to have made magnetic observations until the Challenger called there in 1873, and obtained values of all three elements. H.M.S. "Sapphire" called here in 1883, and obtained a good value of the declination in the process of swinging near the same position as the Challenger. The change in this element may therefore be considered fairly established, whilst for that of the inclination and intensity one is obliged to rely on Sabine's lines for 1842–45, based on observations made in the neighbourhood as a means of comparison with the Challenger's results. Situated in mid-ocean and rarely visited, results obtained at this island form an important link for the purposes of terrestrial magnetism.

Not long after leaving the well-known Cape of Good Hope, the ship anchored in Christmas Harbour, Kerguelen Island, and here another of Ross's positions on land was visited. Unfortunately for our immediate purpose, the stations occupied during the transit of Venus by the Rev. Father Perry were situated in quite a different part of the island, and his otherwise valuable magnetical observations cannot strictly be compared with those of Ross and the Challenger, so that the secular change now adopted depends upon the two latter authorities.

At Cape Town and in the Indian Ocean north of the parallel of 30°, as well as on the coasts of Australia, the secular change of the declination for many years past has been found to be very small, rarely exceeding 1′ annually; it was therefore desirable to know how far to the southward this slight movement of the needle extended. The results from Christmas Harbour show that the north-seeking end of the needle is moving westward at the rate of 5′ annually at least.

It was, however, from two positions on the homeward voyage that the most novel and remarkable values of the secular change were obtained. These were Sandy Point, Magellan Strait, and the island of Ascension with its adjacent waters.

The United States monitor "Monadnock" visited Sandy Point in the year 1866, and took what were probably the first observations with absolute instruments of the three magnetic elements. Subsequently the declination was observed by different vessels, and the absolute horizontal force by H.M.S. "Nassau" in 1868–69. But the secular change of those elements at this station is so moderate,—the horizontal force being nearly stationary and the declination decreasing 3′ annually,—that but little was suspected of the large change which was going on in the inclination until the visit of the Challenger in 1876 disclosed the fact that the latter element was apparently decreasing about 11′ annually. The results obtained by the observers of the French Expedition to Orange Bay in 1882–83, who visited Sandy Point, somewhat modify this

amount of 11′, but quite confirm the general result that a remarkable movement of the needle in a vertical direction is going on there. To estimate, however, the full value of what has just been said, it is necessary to follow further the voyage of the Challenger as far as the island of Ascension. With the marked local magnetic disturbance found on this island it has not been considered a trustworthy method to compare land observations of different epochs not made exactly in the same position.

Sabine's lines for 1842–45, however, are well supported by observation in and near the island, and may be considered a near approximation to exact values. Comparing the Challenger's results by swinging near the island with Sabine's, the following values of the secular change are obtained. The declination is increasing 8′ annually, the south inclination increasing 14′, and the horizontal force decreasing 0·013 (B.U.).

There has been therefore not only considerable annual change going on at the two positions, but the notable fact is made evident that the north-seeking end of the needle is found to be moving in opposite directions, downwards at Sandy Point, and more strongly upwards at Ascension. It was hardly to be expected that such large and opposite movements of the needle should be confined to the spots where they were discovered, and investigations in the surrounding countries and seas prove such to be the case. If therefore the Challenger's observations in the North and South Atlantic Oceans and seaboard were to be utilised satisfactorily for any given epoch, in conjunction with those from various sources, and observed at different times, some means must be adopted of gaining a fairly approximate knowledge of the secular change. Although these remarks apply with special force to the Atlantic, there are sufficient grounds for applying them to all parts of the world.

For this purpose the author of this Report made a collection of a large number of observations of the magnetic elements for all parts of the world—in many cases extending over a long number of years—and these have been discussed, and approximate values of their secular change obtained.

The several values were entered on maps against the positions where the observations were made, and their relative accuracy noted. Thus results from fixed observatories, if taken for a period of fifteen or twenty years, would be accepted as of full weight; whilst others at minor stations, where two or three observations only had been made, and the exact positions of the observers were imperfectly known, one half or one quarter weight would be allotted. This premised, lines of equal value of the secular change were then drawn, and the following general results, as regards the annual angular movement of the north-seeking end of the freely suspended needle during the epoch 1840–80, were found clearly marked out. Commencing with the map showing equal lines of annual change of the declination, it was found that there are two principal lines of little or no change. The first took the following course—Starting from St. John's, Newfoundland, it crossed the Atlantic in a south-easterly direction, striking the west coast of Africa

near Cape de Verde, emerging near Cape Palmas, and passing on to Cape Town; leaving Cape Town, it curved upwards into the Indian Ocean near Mauritius, then downwards south of Cape Leeuwin in Western Australia, again upwards through Australia by Adelaide and Cape York to the vicinity of Hong Kong, and terminating in Siberia in about 60° N. and 120° E. for want of data to trace it further.

The second line passed from Sitka through the western portion of the North American continent, quitting the coast near the meridian of 100° W., then on to the South American coast near Callao, and afterwards following the trend of that coast, reaching the meridian of 80° W. near the entrance to Magellan Strait.

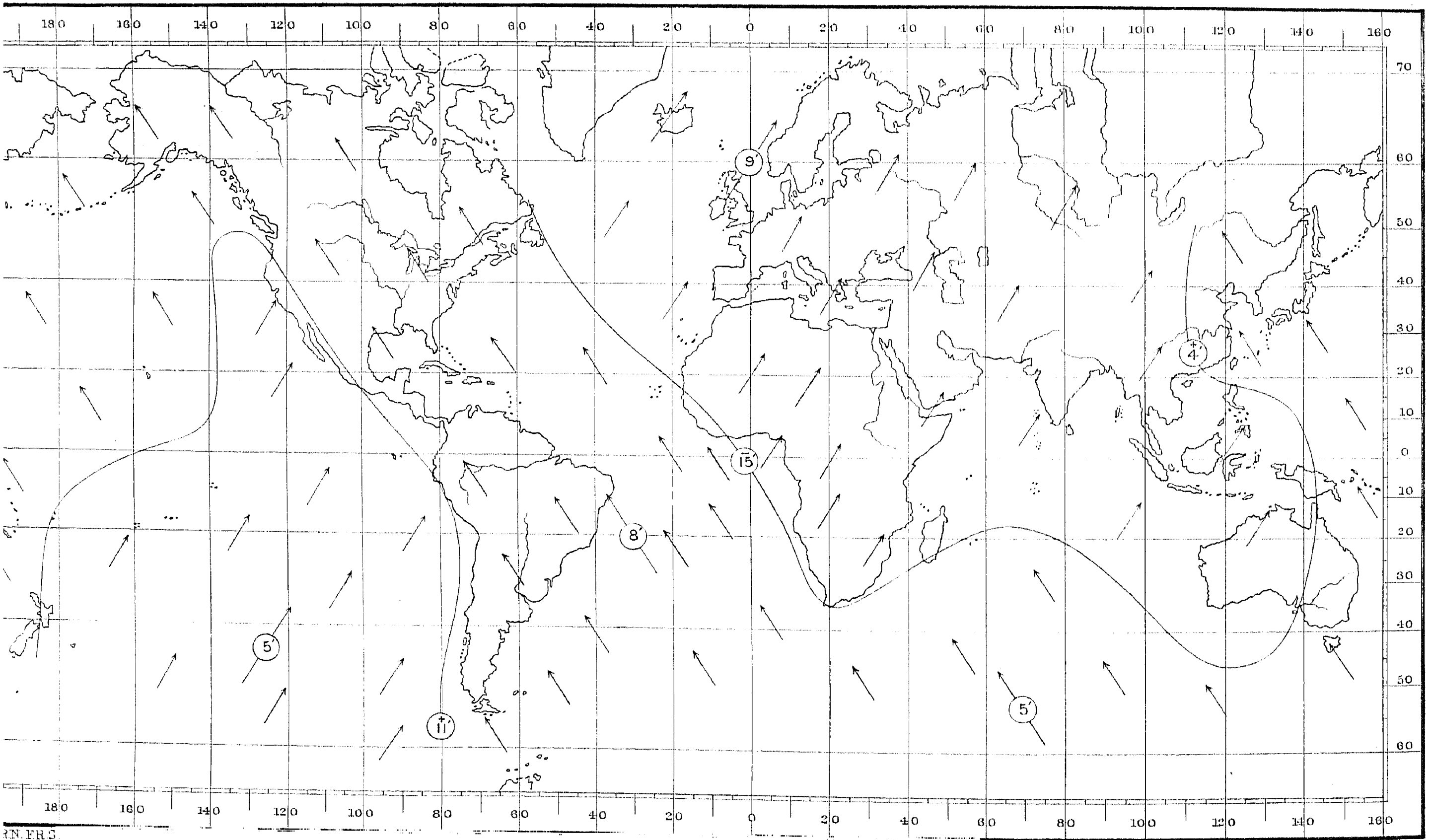
A third line, much less clearly defined, passed from Sitka in a southerly direction to the equator, and then in a south-westerly direction to New Zealand.

The next prominent feature in this map of the secular change were the foci of maximum value. The principal focus was found to be approximately situated between the east coast of Scotland and the west coast of Norway, with a value of about 9′ annual change, needle moving eastward. A second focus appeared on the east coast of Brazil, extending to about the meridian of 20° west longitude, with a value of 8′ in the annual change, needle moving westward. Two minor foci, with a value of 5′, were also shown to exist—one in about 45° S. and 130° W., needle moving eastward; the other near Kerguelen Island, needle moving westward. It may be remarked, however, in passing, that for regions south of 50° S. considerable changes are probably proceeding in the earth's magnetism, for which observation has done but little to elucidate. Another focus apparently exists in the western parts of Alaska, but as yet indeterminate in position and value of change, although probably large in the latter respect, the needle moving westward. The general tendency was for the values of the change to decrease gradually from the foci to the lines of no change.

Now let the results of the map showing equal lines of the secular change of the inclination be considered. Similarly to that of the declination, there are lines of no change, two principal foci of maximum secular change, but only one minor focus. The lines of no change in the inclination, however, were less clearly defined than those of the declination, in a great measure from want of data; but that separating the two principal foci of change may be traced as follows:—Passing through Callao in Peru across the South American continent, emerging between Rio de Janeiro and Bahia, touching the focus of maximum change in the declination off the Brazilian coast, and then taking a south-easterly direction.

The principal focus of change in the inclination was found near the Gulf of Guinea, between Ascension and St. Thomé, and for the sake of distinction may be called the Guinea focus; here the inclination was changing about 15′ annually, the north-seeking end of the needle being repelled *upwards*. The second focus occurred about the 80th meridian of west longitude and the latitude of Cape Horn, and may be called the Cape

SHOWING THE APPROXIMATE DISTRIBUTION OF THE SECULAR CHANGE IN THE DECLINATION OR VARIATION. EPOCH 1840-1880.



RN. F.R.S.

Engraved by Malby & Sons

EXPLANATION.

rows deflected to the right of the true meridian indicate regions in which the North seeking end of the needle is moving Eastward. Arrows deflected to the left that it is moving Westward.

The Black curves pass through regions of no Secular change in the Declination.

5' *Indicate foci of maximum Secular change, the figures giving the annual value. The arrow on the circle the direction in which the needle is moving.*

+1 *Are foci of maximum Secular change in the Inclination, the figures giving the annual value.*

+ *Signifies that the north seeking end of the needle moved downwards.*

− *Signifies that the north seeking end of the needle moved upwards.*

Horn focus. Here the needle was being drawn *downwards* at an annual rate of 11′. The minor focus, showing a value of 4′ in the annual change, the needle being drawn downwards, was found in China, near Hong Kong. It must, however, be distinctly understood that the positions thus described, with the values of change given, have only an approximate value, and that only the general features of the distribution of change in the angular direction of the freely suspended needle are to be accepted as clearly shown by this investigation.

If we may judge by analogy of the changes going on in the Atlantic and its seaboards, there should be a focus of considerable decrease in the vertical force in the neighbourhood of the assigned position of the north magnetic pole between the focus of declination change in the German Ocean and that in Alaska; but the suggestion will not be followed further at present. The small map (Plate II.), showing the general direction of the changes which were in progress during the years 1840–80, may perhaps be consulted with advantage in illustration of the preceding remarks.

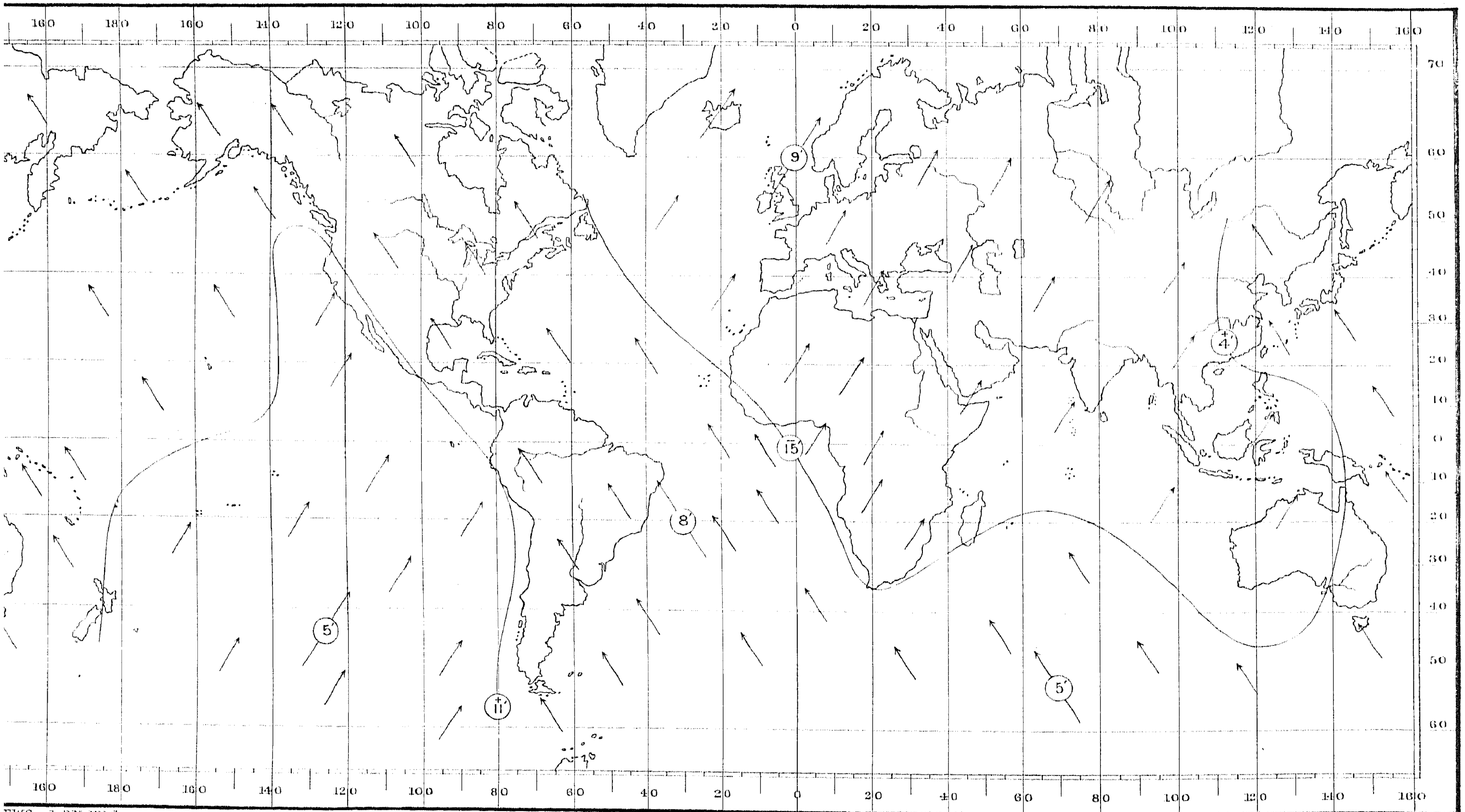
In this map the regions of no secular change in the declination are shown by continuous lines, and the peculiar trend of the line from Sitka to Magellan Strait, following so nearly the general direction of the coast, is remarkable. The foci of maximum change are marked by circles containing a number giving the amount, and the attached arrow shows the direction, *i.e.* when the arrow is shown as deflected to the right of the true meridian, the north-seeking end of the needle is moving to the eastward, and when deflected to left, to the westward. The other arrows similarly show the general direction in which the needle is moving. The foci of maximum change in the inclination are marked by circles containing a number showing the amount, the sign + signifying that the north end of the needle is moving downwards, and the sign − the contrary movement.

With regard to the maps of secular change in the earth's magnetic intensity, although some remarkable points of interest are shown, they fall short in their value as an approximation to the truth as compared with the other elements,—the declination values having been much longer and generally observed, and next to it the inclination.

In the horizontal force the more remarkable features were, the small annual change near Cape Horn, about − 0·002 (B.U.), the focus of greatest change amounting to − 0·017 between Valparaiso and Monte Video, and the gradually diminishing values on the American continent until a zero line is met, starting from the great North American lakes, across the Atlantic south of Bermuda, to the Cape de Verde Islands. This decreasing annual change apparently extended across the Pacific Ocean in diminishing value to Tahiti, over the South Atlantic to Southern Africa, and across that continent to the east coast.

To the northward and eastward of this zero the annual change showed signs of

MAP SHOWING THE APPROXIMATE DISTRIBUTION OF THE SECULAR CHANGE IN THE DECLINATION OR VARIATION. EPOCH 1840–1880.



E.W. Creak R.N. F.R.S.

Engraved by Malby & Sons.

EXPLANATION.

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The Black curves pass through regions of no Secular change in the Declination.

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To the northward and eastward of this zero the annual change showed signs of

increasing in amount until a focus of + 0·009 was found on the west coast of Portugal, gradually diminishing again towards the Atlantic seaboard of North America on the west, and towards the Aral Sea on the east. In China, also, there appears to be a minor focus of increasing annual change.

But the changes going on in the horizontal component of the earth's intensity were far exceeded by those in the vertical component. Commencing at the Cape Horn focus there was found an annual change in the vertical force of 0·055 (B.U.), drawing the north-seeking end of the needle *downwards*, the change diminishing in value until the zero line, extending from Callao across the American continent to the west coast between Bahia and Rio de Janeiro, and then taking a south-easterly course north of Tristan da Cunha, was reached. To the northward and eastward of this zero line, there were found increasing values in the annual change in the *upward* vertical force acting on the north-seeking end of the needle, until the Guinea focus was reached, where its full value was increasing 0·025 annually. From the Guinea focus to Northern Europe, Asia, and the Atlantic seaboard, the change gradually decreased in amount. In China a minor focus of change in this element was found, the north-seeking end of the needle being drawn downwards. Apparently there was no great change going on in the Indian and Pacific Oceans, but there were signs of increase in the vertical force on the west coast of Mexico and the United States as far as San Francisco.

From these remarks upon the means adopted for obtaining the corrections for observations taken at different epochs, it may be fairly accepted that the possibilities of error in reducing them to the common epoch of 1880 have been brought within satisfactory limits, especially as one of the chief factors in the compilation of the maps of the three elements — the observations taken in the Challenger — were separated from it by only a mean number of five years.

Hitherto only the special points of interest in the Challenger's results have been reviewed in their order of time, but the ship's track may now be usefully followed as marked out by magnetic observations. These were begun late in 1872; when starting from England the ship went to Lisbon, and on to Gibraltar, where the first swinging abroad took place, and shore observations were made. These were valuable, as little had been done for terrestrial magnetism at the latter place since the visit of the Austrian frigate "Novara" in 1857. Proceeding on the voyage by Madeira and Tenerife, and westward near the parallel of 20° N., the island of St. Thomas was reached; thence northward to Bermuda and Halifax, N.S., back to Bermuda, and on to the Azores, and a second time to Madeira. A large portion of this division of the voyage was over entirely new ground. Sailing south by way of St. Vincent, Cape de Verde Islands, and St. Paul's Rocks, Bahia, near the magnetic equator, was reached. Complete sets of observations having been made there, the voyage was continued by Tristan da Cunha to Cape Town. It may be remarked that on account of the moderate time

generally occupied, and on account of the large range of magnetic latitude embraced, a voyage from England to the Cape is one of the most useful for testing the magnetic condition of a ship. Full advantage was taken of the visit to Table Bay for ascertaining the various constants of the deviation of the compass, and the relative magnetic instruments, and tables of weight equivalents, observed in order to test the magnetic stability of the deflectors in the Fox circles. Leaving the Cape, the track now lay by Prince Edward Island and the Crozets to Kerguelen Island; thence southward to near the Antarctic Circle, the vessel being swung in lat. 63° 30′ S., long. 90° 47′ E., for observations of the magnetic elements, and thus in probably the most southerly position since the days of Ross in the "Erebus" and "Terror," and very near the track of the "Pagoda" in the year 1845. During this short trip into the Antarctic regions, and the subsequent north-easterly track followed to Melbourne, evidence was obtained of decided change going on in the declination and inclination, but nothing of the remarkable character observed near Cape Horn as regards the inclination.

Having made observations at the well-known stations of Melbourne and Sydney, the ship now traversed portions of the Western Pacific, which are almost blank in Sabine's maps. These were from Sydney, N.S.W., to Wellington, N.Z., northward to the Friendly and Fiji groups of islands, then southward of the New Hebrides to Cape York —one of the stations visited by H.M.S. "Rattlesnake" in 1848 and H.M.S. "Hecate" in 1863—and amongst the islands of the Eastern Archipelago to Manila and Hong Kong. Returning southward by way of Samboangan to the Admiralty Islands and then northward to Yokohama, the North Pacific was crossed about the parallel of 36° N. to 38° N. till the meridian of 155° W. was approached, when a southerly course brought the vessel to the Sandwich Islands, and on to Tahiti. Near these islands the ship was swung with the object of observing the ship's magnetic constants, which were liable to modification, due to the large change of magnetic latitude. From Tahiti to the parallel of 40° S., a south-easterly course was followed, and along that parallel until the time arrived for turning more directly towards Valparaiso. After obtaining base observations at Valparaiso, and swinging, the route now lay towards the island of Juan Fernandez, where the inclination and force were observed, and then by way of the Gulf of Peñas and the Patagonian Channels to Sandy Point, Magellan Strait.

Reviewing the route traversed by the Challenger in the North and South Pacific Oceans, it may be remarked that the observations there made formed one of the most valuable parts of the contribution to terrestrial magnetism obtained in her; for, following a line drawn along the east coast of Australia to Cape York and then across to Hong Kong, other observers had already done good work. Similarly, the lines of equal magnetic value for the west coasts of North and South America were well known. But the novel and valuable parts of the work consisted of the lines of observation from Wellington to Tongatabu, and Fiji—from the Admiralty Islands to Japan, and the mid-

ocean lines passing from nearly 40° N. through the Sandwich Islands and Tahiti to 40° S., nearly at right angles to the curves of equal magnetic inclination.

Having cleared the Magellan Strait, the voyage was continued to the Falkland Islands and Monte Video, thence in an easterly direction until the outward track was crossed, about 300 miles to the westward of Tristan da Cunha, turning in a northerly direction by Ascension until the outward bound track was again crossed to the northward of the terrestrial equator. From the Cape de Verde Islands the last part of the voyage covered new regions westward of the Azores, and then on to England. At Sheerness this voyage of three and a half years' duration was completed, and the final observations made on board the ship as before starting. The instruments were then transferred to Kew for examination and re-determination of the constants.

Of the portability and working of the absolute instruments used during the voyage, there is little to be added to what is generally well known concerning them, as they were of the Kew pattern. Of the three Fox circles used at different times during so long a voyage with the ship so much at sea, subjecting the instruments to the jarring effects of a steamship's screw, it may be well to record here the results of the experience gained. On referring to the numerical results in Narrative, Vol. II., it will be found that index errors of the needles used in these circles became very large; this probably arose from the axles and the jewelled holes in which they worked losing their circular form. These errors would be principally apparent in the observations of the inclination, and point to the necessity of frequent comparisons on land with the Kew dip circle.

With the intensity observations, less dependence upon comparisons with the Unifilar magnetometer on land was required, for although the deflectors lost a certain amount of magnetism during the voyage, as shown by the tables of weight equivalents taken at different intervals, the observations with weights were so often taken at the same time as the deflectors, that by a simple calculation the period when the change took place in the magnetic moment of the deflectors could be nearly found. This was important, for the method of observing the intensity with deflectors was more largely adopted than that by weights; besides, in cold and damp weather, there is, in addition to the object of keeping the needle as little exposed as possible, a greater facility in the manipulation. Again, if deflectors are made of proper steel and carefully preserved from touching, either when in use or packed in the travelling box, there should be little difficulty in ensuring the permanence of their magnetic moment.

With regard to the jarring effects of the screw, much experience has been gained in late years in overcoming it in the case of compasses placed on board ships with engines of very large power and driven at high rates of speed. There seems to be no difficulty in applying such experience to the suspension of the gimbal table on which the Fox

circles are mounted on board ship, especially as it is necessary that the ship should not cover much distance during the time of observation, and consequently the engines be moving slowly.

Having thus followed in detail the various steps which have been taken to produce the representation of the elements of terrestrial magnetism contained in the accompanying charts, a few remarks on the degree of dependence to be placed upon them seem desirable. The most reliable portion will be found in the zone contained between the parallels of 70° N. and 50° S.—the weakest portions of that zone being the interior of Africa and South America, and even on the coasts of the former there is a large space not yet examined for magnetical purposes. In portions of North America, other than the United States where an extensive magnetic survey is in progress, observations are much wanted, especially in the higher latitudes of British America. In the southern hemisphere the regions south of the parallel of 50° S. are largely dependent upon Ross's survey, corrected only by the results obtained in the Challenger, and more recently by those of the International Polar Expedition of 1882–83.

Although on the general question of the secular change of the magnetic elements much has been already written in this Report, there yet remain some important points which demand further discussion.

Referring to the familiar hypothesis of Halley, announced in the early part of the last century, it will be found that its main features were that of a solid globe or terella, with two poles or foci of intensity rotating within and independently of the outer shell of the earth, which also possessed two poles or foci of intensity, the axes of the two globes being inclined one to the other, but having a common centre, the variable relations of these poles causing the secular change.

Again, Hansteen in the early part of the present century, with better materials at hand, came to a conclusion similar to that of Halley, as to there being four poles of attraction. Hansteen "computed both the geographical positions and the probable period of the revolution of this dual system of poles or points of attraction round the terrestrial pole. From computation he found that the North American point or pole required 1740 years to complete its grand circle round the terrestrial pole, the Siberian 860 years, the pole in the Antarctic regions south of Australia 4609 years, and a secondary pole near Cape Horn 1304 years."

In later years Sabine added his opinion, that the secular change is caused by the progressive translation of the point of attraction at present in Northern Siberia, such point of attraction resulting from magnetism induced in the earth by cosmical action. The hypothesis, therefore, of the translation of one or more of the points of greatest attraction or foci of intensity was clearly held by these magneticians.

A later contributor[1] to terrestrial magnetism writes thus: "Sabine and Walker

[1] The late Balfour Stewart.

are agreed in regarding this variation as cosmical in its origin, and they are apparently of opinion that it is caused by some change in the condition of the sun. It seems difficult, if not impossible, to attribute it to anything else, since the terella of Halley cannot be longer regarded as having a physical existence." He then proceeds to give reasons for attributing the secular variation to the result of solar influence of a cumulative nature—(1) an influence on a supposed hard iron system of the earth, and (2) a long continued variation of solar power acting cumulatively on the large ice fields round the poles of the earth—the changes in the ice fields acting cumulatively so as to alter the convection currents of the earth, and these again "might in their turn perceptibly alter the earth's magnetic system."

Keeping in view the hypotheses which have thus been advanced, and recalling the chief results of observation during comparatively recent years which have already been discussed, an inquiry may now be made as to how far they accord.

Observation generally points to the fixity of the magnetic poles—or two limited areas in the earth where the needle is vertical—with respect to the geographical poles; and accepting this conclusion, the proposition of the revolution of one round the other as the cause of the secular change must be dismissed. Again, observation during the present century tends to show that in Northern Siberia very little change in the magnetic elements can be traced, and therefore there is little or no apparent translation of the point of greatest attraction in that region. Similarly the North American focus of intensity is probably at rest.

Thus the results are not satisfactory when a comparison is made between the hypothesis of translation either of the magnetic poles of verticity or of the foci of magnetic intensity with the results of observation in recent years.

To avoid repetition of terms, let Airy's well-known terms of blue and red magnetism be adopted, and also let the movements of the red or north-seeking end of the needle alone be considered.

Now, if a line be traced on a globe from the North Cape of Norway across the Atlantic to Cape Horn, it will pass near some of the foci of greatest known secular change; and what information does observation give concerning those foci? That at the Cape Horn focus of change in the vertical force the needle was moving downwards, or there was the equivalent to a blue pole of increasing power of attraction, the freely suspended needle being attracted towards it over an extended region around. Whilst at the Guinea focus of change in the vertical force the needle was moving upwards, or there was the equivalent to a red pole of increasing power of repulsion, the freely suspended needle being repelled over an extended region of undefined limits. The action of these two poles appears to be strongly marked in the South Atlantic near Brazil, where they apparently combine to produce a focus of considerable angular movement in the horizontal needle.

In like manner, in China there is a minor blue pole of increasing power attracting the freely suspended needle over a large area.

As there does not appear to be any secular change of importance found in Siberia, and the horizontal needle is moving somewhat rapidly to the eastward at, and in the regions surrounding, the focus of change in the declination situated in the German Ocean and similarly to the westward in Alaska, a decrease in the vertical force in the high latitudes of North America, or the equivalent to a red pole of increasing power repelling the freely suspended needle for a large area around it, may by analogy be looked for.

Data of sufficient precision are still wanting for the determination of how far the vertical force of the earth at and about these poles or foci of attraction and repulsion varies at different epochs; yet if the hypothesis of their translation be given up or only accepted as existing over small areas, it is not unreasonable to suppose that the vertical force at these poles has a distinct variation, and that the phenomena of the angular movements of the freely suspended needle, as shown by the secular changes in the declination and inclination, are chiefly dependent upon changes in the relative power of these poles. It must further be remembered that the movements of the horizontal needle are also modified by changes in the horizontal component of the earth's force, increasing force retarding and decreasing force accelerating them.

If the case be thus, the question arises: What are the causes of these remarkable changes in the earth's magnetic force as measured on its surface?

No satisfactory explanation has yet been given, and in the present instance only suggestions can be made based on the far from complete facts available.

The voyage of the Challenger has shown that, in addition to the remarkable local magnetic disturbances which have been found on the great continents, in the solitary islands of the sea surrounded by apparently normal conditions similar local disturbance is found. It has also been suggested that the magnetic portions of these islands causing the disturbance may possibly "have been raised to the earth's surface from the magnetised portion of the earth forming the source of its magnetism," and tending to prove Airy's conclusion, "that the source of magnetism lies deep."

Considering, therefore, the changes which are in progress and have taken place in ages past in the distribution of land in the world, it may fairly be conceived, not only that large changes have likewise occurred in the distribution of its magnetic portions appearing here and there on the surface and producing local magnetic disturbance, but that there are others of a more progressive character below the earth's surface which are only made manifest by the secular change observed in the magnetic elements. Although prominence is thus given to the conception that the secular change is chiefly due to continuous redistribution of magnetised matter in the interior of the

earth, it is not intended to exclude the view that solar influence may have a small share in producing the observed phenomena.

In concluding this Report it may be remarked that however subsequent research may add to, qualify, or reverse, the conclusions drawn from the observations made during the voyage of the Challenger, substantial gains have been won for the science of terrestrial magnetism, forming a sound basis for future magneticians to build upon. The labours of those who planned and started the system of magnetic observations of this voyage, as well as of those who so zealously carried it out, have borne good fruit, of which it may be reserved to others to reap the full benefit.

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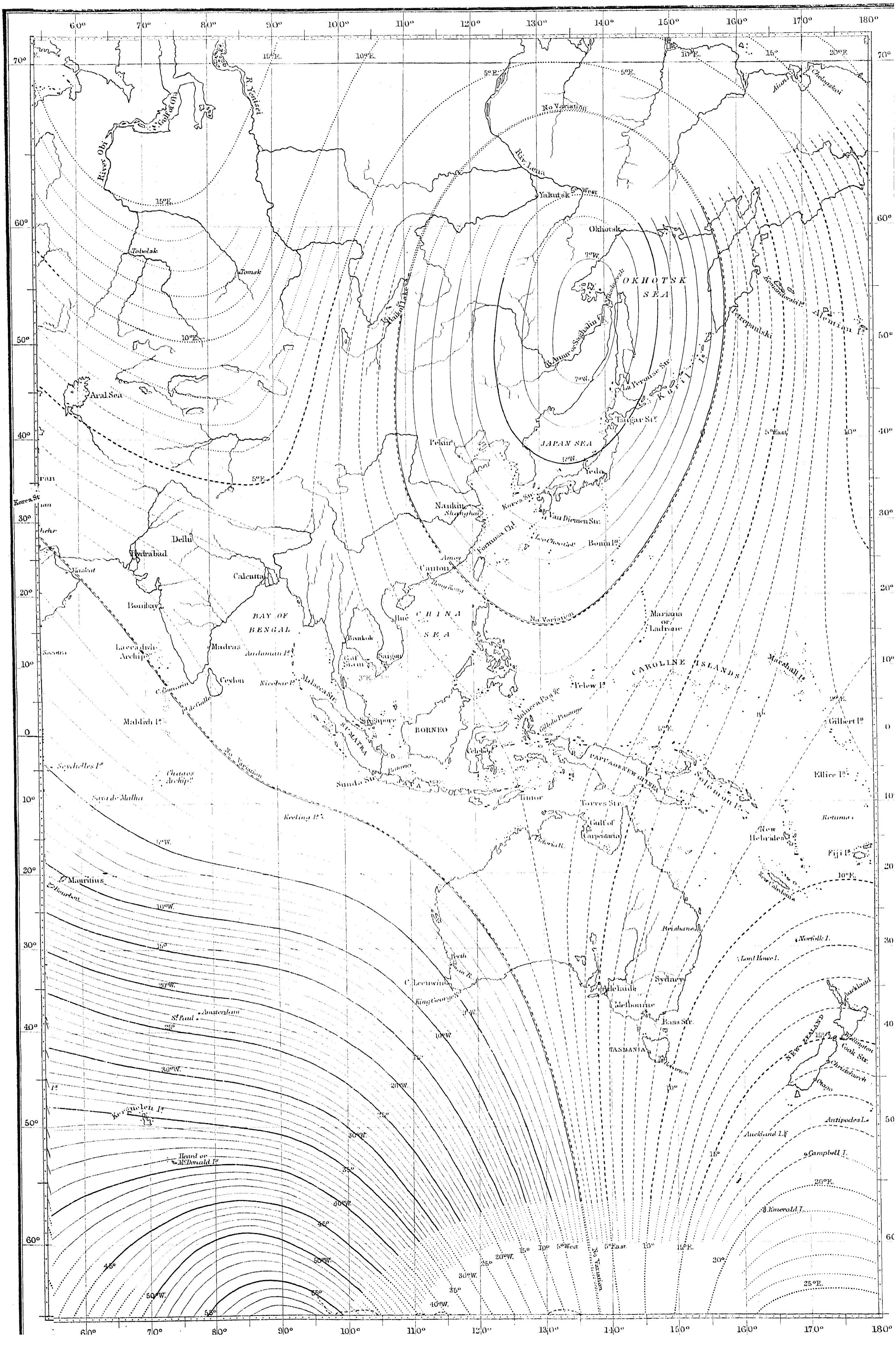

OKHOTSK SEA
JAPAN SEA
BAY OF BENGAL
CHINA SEA
CAROLINE ISLANDS
BORNEO
SUMATRA
PAPUA OR NEW GUINEA
TASMANIA
NEW ZEALAND
No Variation
Aral Sea
Delhi
Calcutta
Bombay
Madras
Ceylon
Canton
Pekin
Nankin
Yakutsk
Okhotsk
Tobolsk
Tomsk
Mauritius
Kerguelen I.
Sydney
Adelaide
Melbourne
Brisbane
Bass Str.
Torres Str.
Gulf of Carpentaria
Fiji Is.
New Hebrides
Solomon Is.
Marshall Is.
Gilbert Is.
Ellice Is.
Timor
Singapore
Saigon
Bankok
Kurile Is.
Aleutian Is.
Petropavlovsk
Bonin Is.
Mariana or Ladrone
Pelew Is.
Seychelles Is.
Chagos Archip.
Maldive Is.
Laccadive Archip.
Keeling Is.
Norfolk I.
Lord Howe I.
Auckland I.
Campbell I.
Antipodes I.
Emerald I.
C. Leeuwin
King George's S.
St. Paul
Amsterdam
Heard or McDonald Is.
River Obi
Gulf of Obi
R. Yenisei
Riv. Lena
Baikal Lake
Saghalin
Amur
La Perouse Str.
Tsugar Str.
Korea Str.
Van Diemen Str.
Formosa Ch.
Yedo
Hongkong
Amoy
Hue
Sunda Str.
Batavia
Malacca Str.
Nicobar Is.
Andaman Is.
Hydrabad
Muskat
Socotra
Saya de Malha
Bourbon
Cook Str.
Wellington
Christchurch
Auckland
Otago
New Caledonia
Rotumah
Gilolo Passage
Celebes
5°E.
10°E.
15°E.
20°E.
25°E.
5°W.
10°W.
15°
20°W.
25°
30°W.
35°
40°W.
45°
50°W.
55°
5° West
5° East
10°
15°
20°
7°W.
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°

CONTENTS.

PETROGRAPHICAL DESCRIPTION OF THE ROCK SPECIMENS.

I.—ROCKS OF TENERIFE.

Few of the volcanic islands of the Atlantic have been the object of such important geological inquiries as Tenerife. It inspired L. von Buch's theory of elevation craters,[1] and since that time it has been very often visited by geologists. A large number of scientific papers have been devoted to its description, among which one of the most important is the remarkable monograph by von Fritsch and Reiss.[2] More recently G. A. Sauer has given a detailed lithological description of the phonolites collected at Tenerife by von Fritsch.[3]

The Challenger Naturalists, on a short visit to Pico de Teyde,[4] collected some specimens, the description of which must, in the absence of stratigraphical details, be limited to a few of those mineralogical and lithological features presented by some of these rocks, that from a petrological point of view deserve to be made known.

Near Puerto d'Orotava, basaltic scoriæ are found; they are greyish-black, rough to the touch, and vesicular; the vesicles, lined with a siliceous coating, measure from 2 to 3 mm. in diameter. None of the constituent minerals can be detected with the naked eye. With the microscope crystals of augite and rare crystals of olivine appear as elements of the first generation. The rather large crystals of augite show very fine examples of polysynthetic twinning, and were it not for the colour of the section, they might, at first sight, be taken for felspathic lamellæ twinned according to the albite law. The adjoining figure (fig. 1) shows some of those elongated sections of augite. The portion marked A is sensibly perpendicular to an optical axis; the portion B extinguishes in a direction parallel to the lengthened edges. In the upper part of the figure the prismatic cleavage is seen; at other points irregular fractures are observed, like those seen in sections of sanidine. Nearly all the sections of augite are twinned as in the figure; sometimes they are broken, and the fragments have been displaced. Olivine is rather rare, and the outlines of its sections are faint; the mineral is altered into serpentine, and the cracks are filled with calcite. A great deal of magnetite is found, but larger opaque patches ought to be

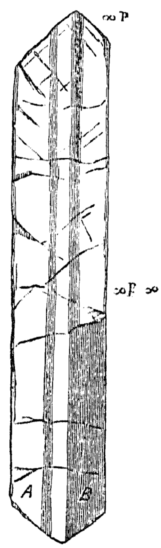


Fig. 1.—Basaltic scoriæ near Puerto d'Orotava. Section of augite with polysynthetic twinning.

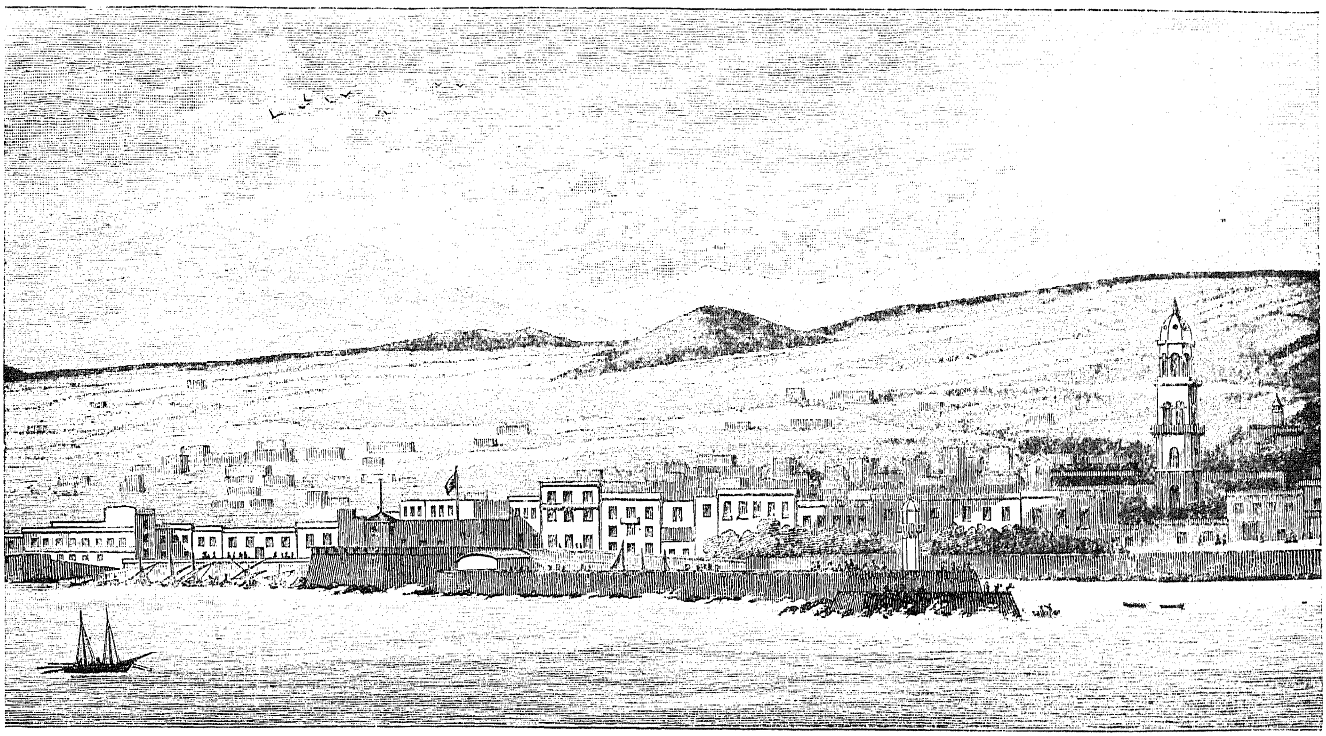
[1] L. von Buch, Physikalische Beschreibung der Canarischen Inseln, Gesammelte Schriften, Bd. iii. p. 229, Berlin 1877.

[2] Von Fritsch und Reiss, Geologische Beschreibung der Insel Teneriffe, 1868.

[3] Sauer, *Zeitschrift f. d. ges. Naturw.*, Bd. xlvii., Halle 1876.

[4] See Narrative of the Cruise of H.M.S. Challenger, vol. i. p. 53.

referred to titaniferous magnetite or to titanic iron. Crystalline outlines observed in these may be ascribed to a regular hexagon. These sections are surrounded by a zone of leucoxene, which appears brownish in transmitted, greyish in reflected, light. The ground-mass is formed by a network of small prismatic augites with rather sharp outlines; a brownish decomposed glassy susbstance is scattered between these, but this base plays a subordinate part. The almost complete absence of plagioclase, the characters of which have only been recognised doubtfully and then only in a few sections, and the predominance of augite, would tend to class this rock with the pyroxenites. The



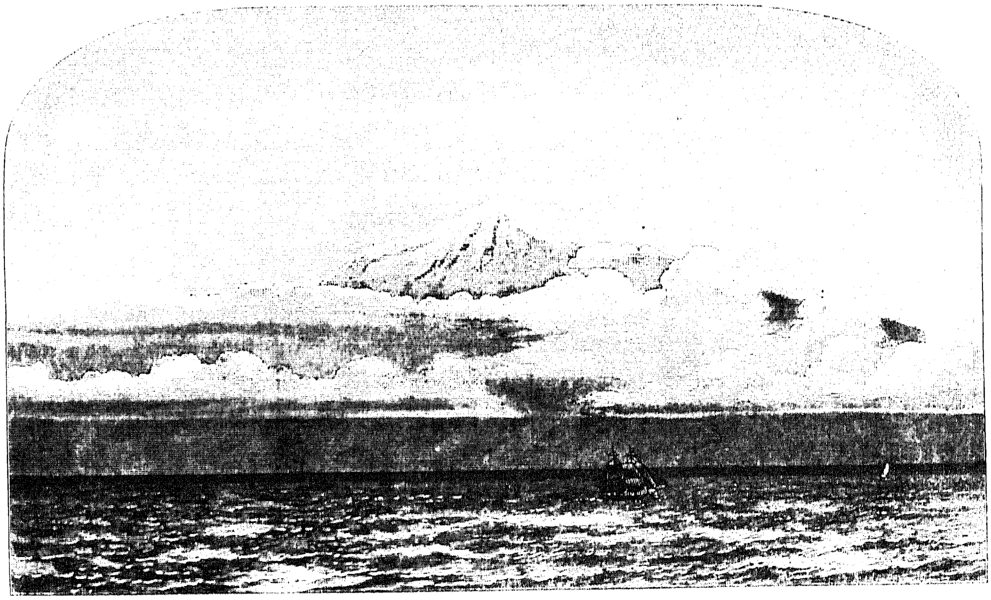
Santa Cruz, Teneriffe.

presence of olivine, on the other hand, connects it with the limburgites, but perhaps this mineral is too subordinate to enable the rock to be classed in the latter group.

Near the same locality, Puerto d'Orotava, a bluish black rock is found; it is filled with small circular vesicles, measuring 2 to 3 mm.; these contain a whitish mealy matter. Its fracture is irregular, and none of the constituent minerals can be distinguished with the naked eye. The specimen in question is a basalt of the felspathic type; its microscopical structure is that of a dolerite. The plagioclase crystals are lamellar, and grains of augite more or less well crystallised are embedded between them; larger sections of olivine are also seen. The plagioclases extinguish under rather large angles; they are very probably a mixture approximating to bytownite. This felspar shows

Carlsbad twins; the two principal individuals exhibit polysynthetic striation, and their extinctions are almost always unsymmetrical. The augite shows itself with the characters which it assumes in basalts. The olivine sections have rounded edges, with a yellowish zone of decomposition; the interior of the mineral is serpentinised, this alteration being made visible by the formation of green fibres penetrating all the fissures. These sections of olivine contain a rather large number of inclusions, with outlines suggesting the form of an octahedron; these are slightly transparent with a brownish tint, and are probably picotite.

The rocks we shall now describe were found in the Cañadas, a remarkable plain covered with scoriæ and shut in on nearly all sides by a perpendicular wall of basaltic



Peak of Tenerife from the N.W., 40 miles.

rock. The present terminal cone of the mountain rises from this vast plain. The Cañadas represent an ancient and much larger crater, in the centre of the remnant of which the more modern smaller peak has been thrown up.[1]

A rock collected at the foot of the Cañadas is a basaltic scoriæ, the vesicles reaching a diameter of 5 to 6 mm.; it is covered with limonite, and a freshly fractured surface shows a compact violet mass. Under the microscope it is seen to be very much altered; its structure is sometimes that of dolerite or that of ordinary basalt. The plagioclase also shows all the transitions from rather large and twinned crystals to the microliths of the paste, which appear as small striæ, and in which the polysynthetic lamellæ can

[1] Narr. Chall. Exp., vol. i. p. 55.

with difficulty be detected. The augite is decomposed; it is yellowish on its edges, the centre still remaining rather violet. The olivine is also altered, being reduced to an external zone, where only the outline of the mineral can be seen. The interior of the section is filled with trichites having a pretty regular disposition and showing rectangular forms; they are associated with small reddish particles. Certain parts only of the olivine polarise, but the colours are not very brilliant. Perhaps we have here an hyalosiderite; this at least seems to be indicated by the great number of trichites, which are also developed in the vitreous decomposed mass forming the ground-mass.

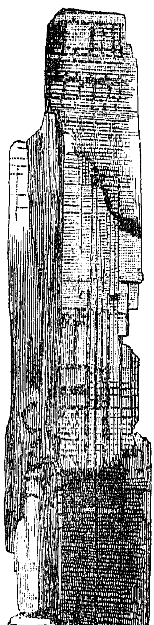


Fig. 2.—Augite-andesite, Cañadas. Section of plagioclase crossed by two series of polysynthetic striæ.

Some other specimens collected in the Cañadas have a waxy appearance when broken, a black colour shading into yellowish brown, with an irregular fracture and containing rather large crystals of sanidine. With the microscope a ground-mass is seen formed by small plagioclases, perhaps also by microliths of sanidine, and by some subordinate vitreous matter. Large sections of plagioclase and of sanidine stand out in this mass. The former show nearly always both the Carlsbad twinning and that of the albite law. They are elongated, with very small extinctions, and ought to be classed in the plagioclastic series near oligoclase and andesine. As frequently occurs with andesine, the hemitropic striæ are exceedingly close and thin. The sections are crossed by two series of polysynthetic striæ; these two systems cut one another under sensibly straight angles, and in polarised light give the section the aspect of microcline, as can be seen in the adjoining figure (fig. 2), only the small veinules of albite are here missing. In some cases these striæ are so faintly visible, that the section might be mistaken for sanidine, but the plagioclastic striæ, be they ever so feebly marked, ought to set aside that interpretation. Sanidine is found in the rock in the form of irregular sections, of rather large size, and twinned according to the Carlsbad law, with the characteristic fissures of that felspar. It can be seen by the undulating extinction that these crystals, like those of plagioclase, have been subjected to mechanical deformation, which altered the optical properties, and renders any subsequent determination difficult. The presence of augite as crystals of the first generation is also ascertained; its pleochroic sections have often indistinct outlines; they are corroded and invaded by the ground-mass. Some small prisms of apatite are also observed, which show, in addition to the usual faces of the prism, a truncation on the edge $0P/\infty P$; they are terminated by the pinacoid $0P$. Magnetic iron is rather frequent; small hexagonal hardly transparent lamellæ are also seen, which may be referred to titanic iron. We have stated that the ground-mass is formed by the accumulation of small felspar crystals; these are of two types. Those of the first type are tabular, with less distinct outlines, and larger sections; those belonging to the second type are

lamellar, their extinction taking place under very small angles, the crystals frequently showing twins without repetition; in short, all seems to indicate that their index of refraction is higher than that of the tabular felspar. The ground-mass reacts like annealed glass between crossed nicols, the tints being hazy. It is uncertain whether these phenomena are to be ascribed to contraction or to pressure which may have acted on the isotropic substance and caused its devitrification. This rock ought to be classed with the pyroxenic andesites containing sanidine, a type related to the trachytic series.

Another rock from the Cañadas is bluish grey, with an irregular fracture; it contains small vesicles with a homogeneous aspect, speckled with black granules. Examination of microscopic slides shows that the rock is a felspathic basalt. The plagioclases, of which numerous sections are seen, have very large lamellæ, and their extinctions are those of labradorite; the augite and the olivine have generally rounded outlines, the latter mineral being decomposed. With these minerals are associated grains and crystals of magnetite, which are rather numerous, and very elongated and truncated prisms of apatite. The ground-mass is formed of a vitreous matter, which is undergoing alteration, as shown by the phenomena of chromatic polarisation it exhibits.

Lastly, a porphyritic lava was collected in the Cañadas. This rock is black, massive, finely grained, scoriaceous, has an irregular fracture, and contains porphyritic felspar crystals. Microscopic examination shows that it has a vitreous base, with very distinct traces of fluidal structure. Crystals of augite, felspar, hornblende, and black mica stand out of the ground-mass, and give the rock a microporphyritic structure. The felspar crystals are twinned according to the albite law, these plagioclastic lamellæ being embedded in two principal individuals twinned according to the Carlsbad law. The separation between the two individuals is clearly marked only on a portion of the length of the section; in several places there is an irregular interpenetration of the two halves. Interposition of biotite scales in the plagioclases can occasionally be ascertained. The same mineral is found as inclusion in augite, as shown in the adjoining figure (fig. 3). The crystals of augite are distinctly prismatic and of light greenish tint, hardly pleochroic. Hornblende is not abundant; its sections are often irregular, sometimes they are aggregated, or form groups. They might be taken for twinned crystals, but there is only a simple juxtaposition; indeed, the lines of cleavage of adjoining sections never follow the direction they would do in the case of true twin crystals. The rays parallel to a are of a pale yellow colour, those parallel to β are reddish.

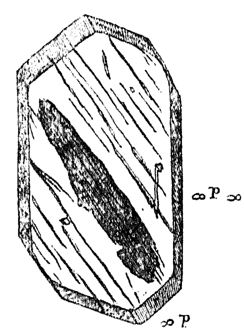


Fig. 3.—Augite-andesite, Cañadas.
Section of augite with biotite lamellæ parallel to a prismatic face.

The most characteristic mineral of the rock, and the most widely distributed, is without doubt biotite; sections cut parallel to the base are very frequently observed; these lamellæ are very pleochroic, the rays vibrating perpendicular to a being of a pale yellow

while those parallel to β are almost black; the shape of these sections is nearly that of elongated parallelograms. This mineral is generally well crystallised; some sections perpendicular to the lamellæ are hexagonal, two of the sides being very elongated, the other much smaller, and the presence of the latter shows that the biotite has crystallised in this rock with pyramidal faces but little developed, truncated by the pinacoid *OP*. The lamellæ parallel to this last face remain dark through a complete rotation between crossed nicols, and in convergent light show a black cross. Sections of magnetite are wedged into the sides of the biotite, which sometimes appears to be altered, and in that case magnetic iron surrounds the decomposed sections. This association appears to show that the magnetite might very well have been derived from the alteration of biotite. In the ground-mass, small plagioclases predominate; these often assume a radial spherulitic arrangement which is repeated with a certain constancy. This rock might be classed among the micaceous augite-andesites.

A rock collected in the middle of the Cañadas is a basalt; it is massive, with more or less nodular blackish grey fracture; it does not show any macroscopic minerals. Under the microscope it is seen to be made up of plagioclase, rather large and irregular sections of olivine, and little crystals of augite; some black mica is also present.

A rock from the top edge of the Cañadas has a compact appearance and is blackish in colour; with the naked eye very elongated crystals of sanidine, embedded in a homogeneous mass, are to be seen. Microscopic examination shows a ground-mass composed of small microliths of felspar more or less radiated, large sections of prismatic and colourless felspar, whose sharp outlines stand out clearly in the surrounding mass. These microporphyritic sections are twinned according to the Carlsbad law, and ought to be referred to sanidine; plagioclastic striæ are never to be observed; the trace of the composition plane divides the section from end to end without ever deviating from a straight line. The usual fissures of sanidine traverse both the twinned individuals as if they formed but one. The extinction of these crystals may be noted here:—Sometimes a section with sharp outlines shows the trace of the twinning reduced to a simple line, in which case it may be assumed that the section is cut nearly perpendicular to the plane of symmetry *v. z. l.* in the zone $P:k$; the extinction of these sections shows that one of the individuals extinguishes nearly always in a direction parallel to the trace of the twinning, and the other at a greater or less angle. Sections, which do not show this sharpness of outline and the trace of the composition plane, ought to be considered as cut obliquely to the zone $P:k$. In this case, if the extinction angles are large and symmetrical, the section is in the zone of the prism; if, on the other hand, they are unsymmetrical and the angular difference very large, it is probable that the section is in the zone $P:M$ of one individual, and in the zone $P:x$ of the other, *i.e.* in a zone in which the extinction of one of the individuals increases but slightly (zone $P:M$), and that of the other rapidly (zone $P:x$). If the extinctions are very small it tends to

prove that the section is in a zone intermediate between the preceding $P:M$ and $x:M$. The determination of the angles of extinction, measured from the trace of the twinning of these crystals, shows that nearly all these felspars have lain parallel to each other in a plane, and that the sections have been cut very nearly perpendicular to the plane of symmetry, inclining slightly to the zone $P:M$. The following extinctions have been measured for the two individuals (left and right):—

Left	Right
0°	5°
0°	7°
0°	13°

These crystals of sanidine are embedded in a finely granular ground-mass containing small lamellar felspars, which may also be considered as belonging to sanidine. These microliths are arranged in tufts, and are associated with very small greenish prisms belonging probably to hornblende. It is seen by the deposit of oxide of iron that the basis of the rock is altered; it was perhaps formerly of a glassy nature.

In the gulleys to the west of Fuente Pedro, a spring situated at the height of 3500 feet, a greyish rock speckled with prismatic crystals of sanidine was collected. This rock has a plane fracture, a waxy lustre, and is very like a phonolite. Microscopic examination shows that the ground-mass contains microporphyritic crystals of sanidine and of plagioclase, which are almost microliths, passing into those constituting the paste; augite and magnetite appear in rather large sections, probably owing their origin to the decomposition of the hornblende. The sanidine sections are large, but their outlines are not sharp; those of the plagioclases, on the other hand, are well defined, notwithstanding the mechanical deformations to which they were subjected. The sanidine shows the characteristic fissures of this mineral, and is twinned according to the Carlsbad law. The deformations produced in this felspar by mechanical action have rendered it fibrous at the extremities of the sections; many of the crystals are bent and broken. A fact that must also be ascribed to these deformations is that the sections show not only undulating polarisation but also deeper colours of chromatic polarisation. Where these phenomena of pressure are observed, instead of seeing the usual pale blue tints of sanidine, the colour is darker; it passes to an indigo tint of marked intensity. We are led to think that this accentuation of tint is caused by mechanical action, which has left its impress on all the constituent minerals of this rock. The crystals of plagioclase are far more numerous than those of sanidine; they are smaller, more elongated, and bent in all directions. These deformations, which are repeated in a marked way in all the sections of plagioclase, are accom-

panied by irregular fractures more or less perpendicular to the length of the crystal (see fig. 4). Augite can only be recognised in the larger crystals; these alone have withstood the pressure. This mineral is polysynthetically twinned; it is generally in a fragmentary condition, filled with fissures. Isolated hornblende cannot be found, but some rather large patches of magnetite surround the small sections of hornblende, forming a kind of zone, and accompanied by very small scales of biotite. This seems to show that the hornblende, once present in the rock, has been replaced by these two minerals. We ought also to mention a mineral playing a rather important part in this rock, sodalite. It is seen in hexagonal or quadratic colourless sections. They are of primary consolidation, as is shown by their forming a centre of aggregation for small crystals of plagioclase, disposed as spherulites round the sodalite. With the condenser a black cross is rather faintly indicated; they cannot be mistaken for nepheline or any other hexagonal mineral, because between crossed nicols all the sections remain obscured. The presence of sodalite in this rock is not an exceptional fact; it is known that this mineral is found in trachytic rocks associated with sanidine and augite, in nearly the same conditions as those we have mentioned. The ground-mass is formed by a network of plagioclase crystals and grains of augite. The rock has a doleritic structure, its mineralogical composition classing it among the augitic andesites, closely allied to trachytes.

Fig. 4.—Augite-andesite near Fuente Pedro. Crystal of sanidine and small crystals of plagioclase, bent and fibrous in the ground-mass.

In the same gulleys of Fuente Pedro a whitish altered rock similar to the preceding was collected. The ground-mass is nearly homogeneous, and contains irregularly disseminated grains of felspar; the fracture of the rock is irregular. Under the microscope the following microporphyritic minerals can be seen: plagioclase, sanidine, augite, and hornblende. Some sections of plagioclase have exceedingly thin polysynthetic striæ over the whole surface. Others show the Carlsbad twinning, and also that of albite; and lastly, some show in addition the periclinic striation crossing the albitic lamellæ. It is rather interesting to notice that, when the sections show the Carlsbad twinning, one of the two halves presents the polysynthetic lamellæ of the albite law, and the other half shows both the albitic and the periclinic striation. This phenomenon tends to prove that these plagioclases have crystallised also according to the Carlsbad law. Indeed, if we bear in mind that the periclinic lamellæ ought to be seen in sections parallel to x, and never in those parallel to P, and that in a Carlsbad twin the faces x

and P, for the two individuals, are placed side by side, we must admit, in order to explain the fact just mentioned, the existence of a Carlsbad twin: sections parallel to P are also parallel to x, and can only show periclinic lamellæ in the individual of which the face x has been cut. Symmetrical extinctions measured in the zone $P:k$ have given, for several cases, values of about 5°; the sections showing the periclinic striæ extinguish at angles of 12° to 14°. This seems to show that we are dealing here with an isomorphous mixture approaching that of oligoclase. There are also small sections of felspar, the physical characters of which contrast with those that we have just described. They are more corroded, have less regular outlines, and are crossed by fractures; polarised light shows that they have crystallised according to the Carlsbad law, and do not show the polysynthetic striæ. The angles of extinction are usually rather large, but at the same time it is noticed that the outlines are feebly marked; this shows that these sections belong to a zone intermediate between the zones $P:M$ and $k:M$, closer to the latter. The frequency of these larger extinctions would prove that this felspar is more developed in the direction of the vertical axis than in the direction of the edge P/M. The crystals of hornblende have a very broken appearance, and are greatly elongated. One cleavage predominates, and irregular fractures are observed nearly perpendicular to that direction; these fractures are caused most likely by mechanical action due to the contracting mass, giving rise to deformation in all the constituent minerals of the rock. The polarisation colours of the hornblende sections are orange, and show that decomposition is taking place. Extinctions of 4° or 5° have been measured; pleochroism is very marked.

γ	$>$	β	$>$	α
dark brown		yellow brown		pale yellow

The sections perpendicular to the axis c are very rare and ill-defined, as may be expected from the very prismatic form of hornblende in this rock. Augite is more plentiful than hornblende; it is elongated like the latter, and often shows twinning according to the usual law; sometimes the sections are polysynthetically twinned, symmetrical extinctions on both sides of the twinned lamellæ measured 38°. This augite is not pleochroic; yellowish spots are seen in the interior of the section, indicating incipient decomposition. Like the hornblende, this mineral often shows fractures and crevices caused by mechanical action. Numerous grains and crystals of magnetite are often accumulated in certain points. The ground-mass is composed of an aggregation of small elongated felspar crystals, interwoven in all directions, and very small augitic sections are wedged between them. The felspar microliths ought to be ascribed, like the microporphyritic individuals, to sanidine or to a plagioclase with small extinctions, twinned according to the Carlsbad law and that of albite. The small felspars of the ground-mass, which we also ascribe to sanidine, show the Carlsbad twinning without any trace of plagioclastic striæ. The features of the

near Cape de Verde, emerging near Cape Palmas, and passing on to Cape Town; leaving Cape Town, it curved upwards into the Indian Ocean near Mauritius, then downwards south of Cape Leeuwin in Western Australia, again upwards through Australia by Adelaide and Cape York to the vicinity of Hong Kong, and terminating in Siberia in about 60° N. and 120° E. for want of data to trace it further.

The second line passed from Sitka through the western portion of the North American continent, quitting the coast near the meridian of 100° W., then on to the South American coast near Callao, and afterwards following the trend of that coast, reaching the meridian of 80° W. near the entrance to Magellan Strait.

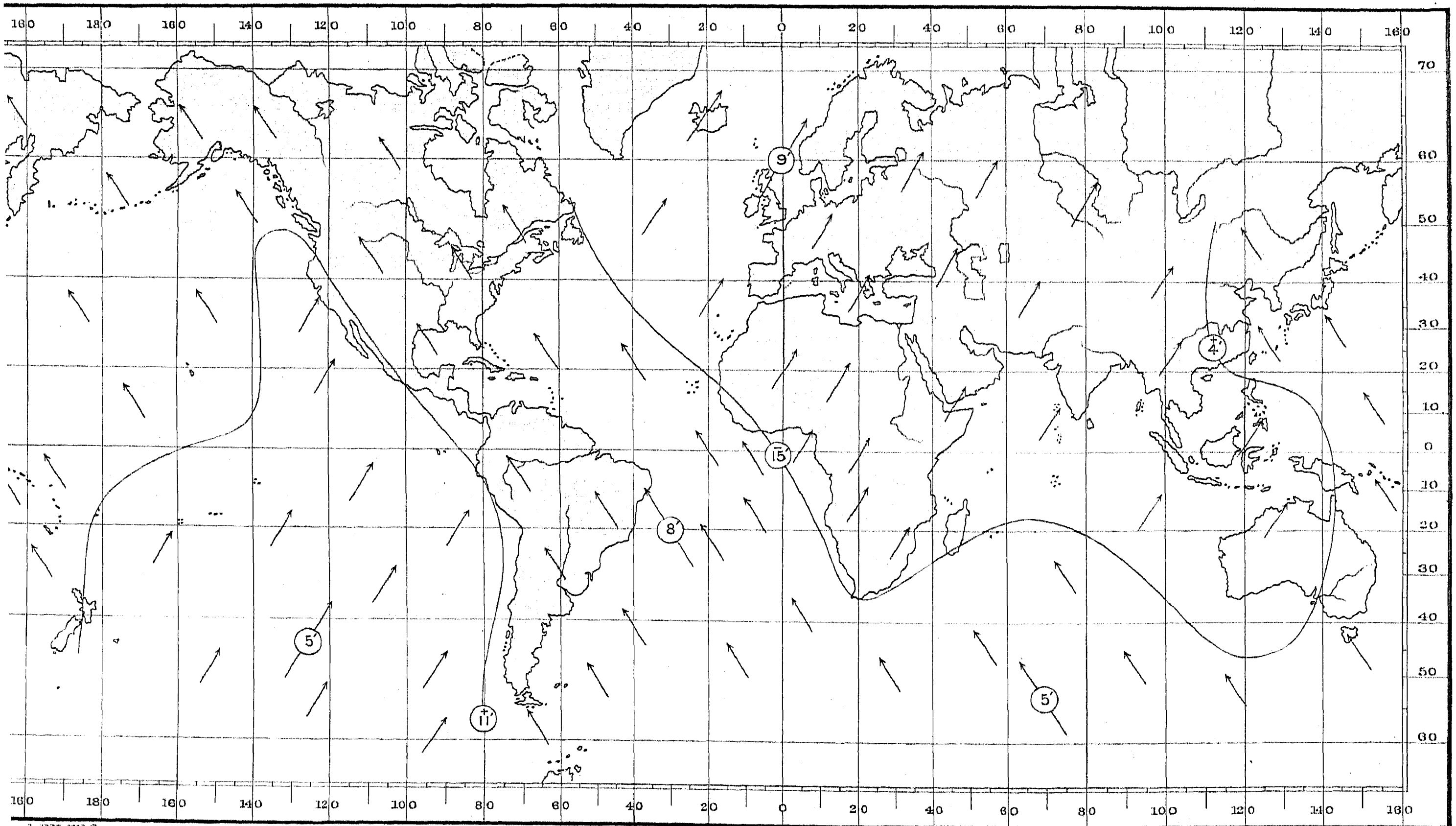
A third line, much less clearly defined, passed from Sitka in a southerly direction to the equator, and then in a south-westerly direction to New Zealand.

The next prominent feature in this map of the secular change were the foci of maximum value. The principal focus was found to be approximately situated between the east coast of Scotland and the west coast of Norway, with a value of about 9′ annual change, needle moving eastward. A second focus appeared on the east coast of Brazil, extending to about the meridian of 20° west longitude, with a value of 8′ in the annual change, needle moving westward. Two minor foci, with a value of 5′, were also shown to exist—one in about 45° S. and 130° W., needle moving eastward; the other near Kerguelen Island, needle moving westward. It may be remarked, however, in passing, that for regions south of 50° S. considerable changes are probably proceeding in the earth's magnetism, for which observation has done but little to elucidate. Another focus apparently exists in the western parts of Alaska, but as yet indeterminate in position and value of change, although probably large in the latter respect, the needle moving westward. The general tendency was for the values of the change to decrease gradually from the foci to the lines of no change.

Now let the results of the map showing equal lines of the secular change of the inclination be considered. Similarly to that of the declination, there are lines of no change, two principal foci of maximum secular change, but only one minor focus. The lines of no change in the inclination, however, were less clearly defined than those of the declination, in a great measure from want of data; but that separating the two principal foci of change may be traced as follows:—Passing through Callao in Peru across the South American continent, emerging between Rio de Janeiro and Bahia, touching the focus of maximum change in the declination off the Brazilian coast, and then taking a south-easterly direction.

The principal focus of change in the inclination was found near the Gulf of Guinea, between Ascension and St. Thomé, and for the sake of distinction may be called the Guinea focus; here the inclination was changing about 15′ annually, the north-seeking end of the needle being repelled *upwards*. The second focus occurred about the 80th meridian of west longitude and the latitude of Cape Horn, and may be called the Cape

AP SHOWING THE APPROXIMATE DISTRIBUTION OF THE SECULAR CHANGE IN THE DECLINATION OR VARIATION.—EPOCH 1840-1880.



reak R.N. F.R.S.   Engraved by Malby & Sons

EXPLANATION.

ıe arrows deflected to the right of the true meridian indicate regions in which the North seeking end of the needle is moving Eastward. Arrows deflected to the left that it is moving Westward.
The Black curves pass through regions of no Secular change in the Declination.

(5) Indicate foci of maximum Secular change, the figures giving the annual value. The arrow on the circle the direction in which the needle is moving.

(11) Are foci of maximum Secular change in the Inclination, the figures giving the annual value.
+ Signifies that the north seeking end of the needle moved downwards.
− Signifies that the north seeking end of the needle moved upwards.

Horn focus. Here the needle was being drawn *downwards* at an annual rate of 11′. The minor focus, showing a value of 4′ in the annual change, the needle being drawn downwards, was found in China, near Hong Kong. It must, however, be distinctly understood that the positions thus described, with the values of change given, have only an approximate value, and that only the general features of the distribution of change in the angular direction of the freely suspended needle are to be accepted as clearly shown by this investigation.

If we may judge by analogy of the changes going on in the Atlantic and its sea-boards, there should be a focus of considerable decrease in the vertical force in the neighbourhood of the assigned position of the north magnetic pole between the focus of declination change in the German Ocean and that in Alaska; but the suggestion will not be followed further at present. The small map (Plate II.), showing the general direction of the changes which were in progress during the years 1840–80, may perhaps be consulted with advantage in illustration of the preceding remarks.

In this map the regions of no secular change in the declination are shown by continuous lines, and the peculiar trend of the line from Sitka to Magellan Strait, following so nearly the general direction of the coast, is remarkable. The foci of maximum change are marked by circles containing a number giving the amount, and the attached arrow shows the direction, *i.e.* when the arrow is shown as deflected to the right of the true meridian, the north-seeking end of the needle is moving to the eastward, and when deflected to left, to the westward. The other arrows similarly show the general direction in which the needle is moving. The foci of maximum change in the inclination are marked by circles containing a number showing the amount, the sign + signifying that the north end of the needle is moving downwards, and the sign − the contrary movement.

With regard to the maps of secular change in the earth's magnetic intensity, although some remarkable points of interest are shown, they fall short in their value as an approximation to the truth as compared with the other elements,—the declination values having been much longer and generally observed, and next to it the inclination.

In the horizontal force the more remarkable features were, the small annual change near Cape Horn, about − 0·002 (B.U.), the focus of greatest change amounting to − 0·017 between Valparaiso and Monte Video, and the gradually diminishing values on the American continent until a zero line is met, starting from the great North American lakes, across the Atlantic south of Bermuda, to the Cape de Verde Islands. This decreasing annual change apparently extended across the Pacific Ocean in diminishing value to Tahiti, over the South Atlantic to Southern Africa, and across that continent to the east coast.

To the northward and eastward of this zero the annual change showed signs of

increasing in amount until a focus of + 0·009 was found on the west coast of Portugal, gradually diminishing again towards the Atlantic seaboard of North America on the west, and towards the Aral Sea on the east. In China, also, there appears to be a minor focus of increasing annual change.

But the changes going on in the horizontal component of the earth's intensity were far exceeded by those in the vertical component. Commencing at the Cape Horn focus there was found an annual change in the vertical force of 0·055 (B.U.), drawing the north-seeking end of the needle *downwards*, the change diminishing in value until the zero line, extending from Callao across the American continent to the west coast between Bahia and Rio de Janeiro, and then taking a south-easterly course north of Tristan da Cunha, was reached. To the northward and eastward of this zero line, there were found increasing values in the annual change in the *upward* vertical force acting on the north-seeking end of the needle, until the Guinea focus was reached, where its full value was increasing 0·025 annually. From the Guinea focus to Northern Europe, Asia, and the Atlantic seaboard, the change gradually decreased in amount. In China a minor focus of change in this element was found, the north-seeking end of the needle being drawn downwards. Apparently there was no great change going on in the Indian and Pacific Oceans, but there were signs of increase in the vertical force on the west coast of Mexico and the United States as far as San Francisco.

From these remarks upon the means adopted for obtaining the corrections for observations taken at different epochs, it may be fairly accepted that the possibilities of error in reducing them to the common epoch of 1880 have been brought within satisfactory limits, especially as one of the chief factors in the compilation of the maps of the three elements — the observations taken in the Challenger — were separated from it by only a mean number of five years.

Hitherto only the special points of interest in the Challenger's results have been reviewed in their order of time, but the ship's track may now be usefully followed as marked out by magnetic observations. These were begun late in 1872; when starting from England the ship went to Lisbon, and on to Gibraltar, where the first swinging abroad took place, and shore observations were made. These were valuable, as little had been done for terrestrial magnetism at the latter place since the visit of the Austrian frigate "Novara" in 1857. Proceeding on the voyage by Madeira and Tenerife, and westward near the parallel of 20° N., the island of St. Thomas was reached; thence northward to Bermuda and Halifax, N.S., back to Bermuda, and on to the Azores, and a second time to Madeira. A large portion of this division of the voyage was over entirely new ground. Sailing south by way of St. Vincent, Cape de Verde Islands, and St. Paul's Rocks, Bahia, near the magnetic equator, was reached. Complete sets of observations having been made there, the voyage was continued by Tristan da Cunha to Cape Town. It may be remarked that on account of the moderate time

generally occupied, and on account of the large range of magnetic latitude embraced, a voyage from England to the Cape is one of the most useful for testing the magnetic condition of a ship. Full advantage was taken of the visit to Table Bay for ascertaining the various constants of the deviation of the compass, and the relative magnetic instruments, and tables of weight equivalents, observed in order to test the magnetic stability of the deflectors in the Fox circles. Leaving the Cape, the track now lay by Prince Edward Island and the Crozets to Kerguelen Island; thence southward to near the Antarctic Circle, the vessel being swung in lat. 63° 30′ S., long. 90° 47′ E., for observations of the magnetic elements, and thus in probably the most southerly position since the days of Ross in the "Erebus" and "Terror," and very near the track of the "Pagoda" in the year 1845. During this short trip into the Antarctic regions, and the subsequent north-easterly track followed to Melbourne, evidence was obtained of decided change going on in the declination and inclination, but nothing of the remarkable character observed near Cape Horn as regards the inclination.

Having made observations at the well-known stations of Melbourne and Sydney, the ship now traversed portions of the Western Pacific, which are almost blank in Sabine's maps. These were from Sydney, N.S.W., to Wellington, N.Z., northward to the Friendly and Fiji groups of islands, then southward of the New Hebrides to Cape York —one of the stations visited by H.M.S. "Rattlesnake" in 1848 and H.M.S. "Hecate" in 1863—and amongst the islands of the Eastern Archipelago to Manila and Hong Kong. Returning southward by way of Samboangan to the Admiralty Islands and then northward to Yokohama, the North Pacific was crossed about the parallel of 36° N. to 38° N. till the meridian of 155° W. was approached, when a southerly course brought the vessel to the Sandwich Islands, and on to Tahiti. Near these islands the ship was swung with the object of observing the ship's magnetic constants, which were liable to modification, due to the large change of magnetic latitude. From Tahiti to the parallel of 40° S., a south-easterly course was followed, and along that parallel until the time arrived for turning more directly towards Valparaiso. After obtaining base observations at Valparaiso, and swinging, the route now lay towards the island of Juan Fernandez, where the inclination and force were observed, and then by way of the Gulf of Peñas and the Patagonian Channels to Sandy Point, Magellan Strait.

Reviewing the route traversed by the Challenger in the North and South Pacific Oceans, it may be remarked that the observations there made formed one of the most valuable parts of the contribution to terrestrial magnetism obtained in her; for, following a line drawn along the east coast of Australia to Cape York and then across to Hong Kong, other observers had already done good work. Similarly, the lines of equal magnetic value for the west coasts of North and South America were well known. But the novel and valuable parts of the work consisted of the lines of observation from Wellington to Tongatabu, and Fiji—from the Admiralty Islands to Japan, and the mid-

ocean lines passing from nearly 40° N. through the Sandwich Islands and Tahiti to 40° S., nearly at right angles to the curves of equal magnetic inclination.

Having cleared the Magellan Strait, the voyage was continued to the Falkland Islands and Monte Video, thence in an easterly direction until the outward track was crossed, about 300 miles to the westward of Tristan da Cunha, turning in a northerly direction by Ascension until the outward bound track was again crossed to the northward of the terrestrial equator. From the Cape de Verde Islands the last part of the voyage covered new regions westward of the Azores, and then on to England. At Sheerness this voyage of three and a half years' duration was completed, and the final observations made on board the ship as before starting. The instruments were then transferred to Kew for examination and re-determination of the constants.

Of the portability and working of the absolute instruments used during the voyage, there is little to be added to what is generally well known concerning them, as they were of the Kew pattern. Of the three Fox circles used at different times during so long a voyage with the ship so much at sea, subjecting the instruments to the jarring effects of a steamship's screw, it may be well to record here the results of the experience gained. On referring to the numerical results in Narrative, Vol. II., it will be found that index errors of the needles used in these circles became very large; this probably arose from the axles and the jewelled holes in which they worked losing their circular form. These errors would be principally apparent in the observations of the inclination, and point to the necessity of frequent comparisons on land with the Kew dip circle.

With the intensity observations, less dependence upon comparisons with the Unifilar magnetometer on land was required, for although the deflectors lost a certain amount of magnetism during the voyage, as shown by the tables of weight equivalents taken at different intervals, the observations with weights were so often taken at the same time as the deflectors, that by a simple calculation the period when the change took place in the magnetic moment of the deflectors could be nearly found. This was important, for the method of observing the intensity with deflectors was more largely adopted than that by weights; besides, in cold and damp weather, there is, in addition to the object of keeping the needle as little exposed as possible, a greater facility in the manipulation. Again, if deflectors are made of proper steel and carefully preserved from touching, either when in use or packed in the travelling box, there should be little difficulty in ensuring the permanence of their magnetic moment.

With regard to the jarring effects of the screw, much experience has been gained in late years in overcoming it in the case of compasses placed on board ships with engines of very large power and driven at high rates of speed. There seems to be no difficulty in applying such experience to the suspension of the gimbal table on which the Fox

circles are mounted on board ship, especially as it is necessary that the ship should not cover much distance during the time of observation, and consequently the engines be moving slowly.

Having thus followed in detail the various steps which have been taken to produce the representation of the elements of terrestrial magnetism contained in the accompanying charts, a few remarks on the degree of dependence to be placed upon them seem desirable. The most reliable portion will be found in the zone contained between the parallels of 70° N. and 50° S.—the weakest portions of that zone being the interior of Africa and South America, and even on the coasts of the former there is a large space not yet examined for magnetical purposes. In portions of North America, other than the United States where an extensive magnetic survey is in progress, observations are much wanted, especially in the higher latitudes of British America. In the southern hemisphere the regions south of the parallel of 50° S. are largely dependent upon Ross's survey, corrected only by the results obtained in the Challenger, and more recently by those of the International Polar Expedition of 1882–83.

Although on the general question of the secular change of the magnetic elements much has been already written in this Report, there yet remain some important points which demand further discussion.

Referring to the familiar hypothesis of Halley, announced in the early part of the last century, it will be found that its main features were that of a solid globe or terella, with two poles or foci of intensity rotating within and independently of the outer shell of the earth, which also possessed two poles or foci of intensity, the axes of the two globes being inclined one to the other, but having a common centre, the variable relations of these poles causing the secular change.

Again, Hansteen in the early part of the present century, with better materials at hand, came to a conclusion similar to that of Halley, as to there being four poles of attraction. Hansteen "computed both the geographical positions and the probable period of the revolution of this dual system of poles or points of attraction round the terrestrial pole. From computation he found that the North American point or pole required 1740 years to complete its grand circle round the terrestrial pole, the Siberian 860 years, the pole in the Antarctic regions south of Australia 4609 years, and a secondary pole near Cape Horn 1304 years."

In later years Sabine added his opinion, that the secular change is caused by the progressive translation of the point of attraction at present in Northern Siberia, such point of attraction resulting from magnetism induced in the earth by cosmical action. The hypothesis, therefore, of the translation of one or more of the points of greatest attraction or foci of intensity was clearly held by these magneticians.

A later contributor[1] to terrestrial magnetism writes thus: "Sabine and Walker

[1] The late Balfour Stewart.

are agreed in regarding this variation as cosmical in its origin, and they are apparently of opinion that it is caused by some change in the condition of the sun. It seems difficult, if not impossible, to attribute it to anything else, since the terella of Halley cannot be longer regarded as having a physical existence." He then proceeds to give reasons for attributing the secular variation to the result of solar influence of a cumulative nature—(1) an influence on a supposed hard iron system of the earth, and (2) a long continued variation of solar power acting cumulatively on the large ice fields round the poles of the earth—the changes in the ice fields acting cumulatively so as to alter the convection currents of the earth, and these again "might in their turn perceptibly alter the earth's magnetic system."

Keeping in view the hypotheses which have thus been advanced, and recalling the chief results of observation during comparatively recent years which have already been discussed, an inquiry may now be made as to how far they accord.

Observation generally points to the fixity of the magnetic poles—or two limited areas in the earth where the needle is vertical—with respect to the geographical poles; and accepting this conclusion, the proposition of the revolution of one round the other as the cause of the secular change must be dismissed. Again, observation during the present century tends to show that in Northern Siberia very little change in the magnetic elements can be traced, and therefore there is little or no apparent translation of the point of greatest attraction in that region. Similarly the North American focus of intensity is probably at rest.

Thus the results are not satisfactory when a comparison is made between the hypothesis of translation either of the magnetic poles of verticity or of the foci of magnetic intensity with the results of observation in recent years.

To avoid repetition of terms, let Airy's well-known terms of blue and red magnetism be adopted, and also let the movements of the red or north-seeking end of the needle alone be considered.

Now, if a line be traced on a globe from the North Cape of Norway across the Atlantic to Cape Horn, it will pass near some of the foci of greatest known secular change; and what information does observation give concerning those foci? That at the Cape Horn focus of change in the vertical force the needle was moving downwards, or there was the equivalent to a blue pole of increasing power of attraction, the freely suspended needle being attracted towards it over an extended region around. Whilst at the Guinea focus of change in the vertical force the needle was moving upwards, or there was the equivalent to a red pole of increasing power of repulsion, the freely suspended needle being repelled over an extended region of undefined limits. The action of these two poles appears to be strongly marked in the South Atlantic near Brazil, where they apparently combine to produce a focus of considerable angular movement in the horizontal needle.

In like manner, in China there is a minor blue pole of increasing power attracting the freely suspended needle over a large area.

As there does not appear to be any secular change of importance found in Siberia, and the horizontal needle is moving somewhat rapidly to the eastward at, and in the regions surrounding, the focus of change in the declination situated in the German Ocean and similarly to the westward in Alaska, a decrease in the vertical force in the high latitudes of North America, or the equivalent to a red pole of increasing power repelling the freely suspended needle for a large area around it, may by analogy be looked for.

Data of sufficient precision are still wanting for the determination of how far the vertical force of the earth at and about these poles or foci of attraction and repulsion varies at different epochs; yet if the hypothesis of their translation be given up or only accepted as existing over small areas, it is not unreasonable to suppose that the vertical force at these poles has a distinct variation, and that the phenomena of the angular movements of the freely suspended needle, as shown by the secular changes in the declination and inclination, are chiefly dependent upon changes in the relative power of these poles. It must further be remembered that the movements of the horizontal needle are also modified by changes in the horizontal component of the earth's force, increasing force retarding and decreasing force accelerating them.

If the case be thus, the question arises: What are the causes of these remarkable changes in the earth's magnetic force as measured on its surface?

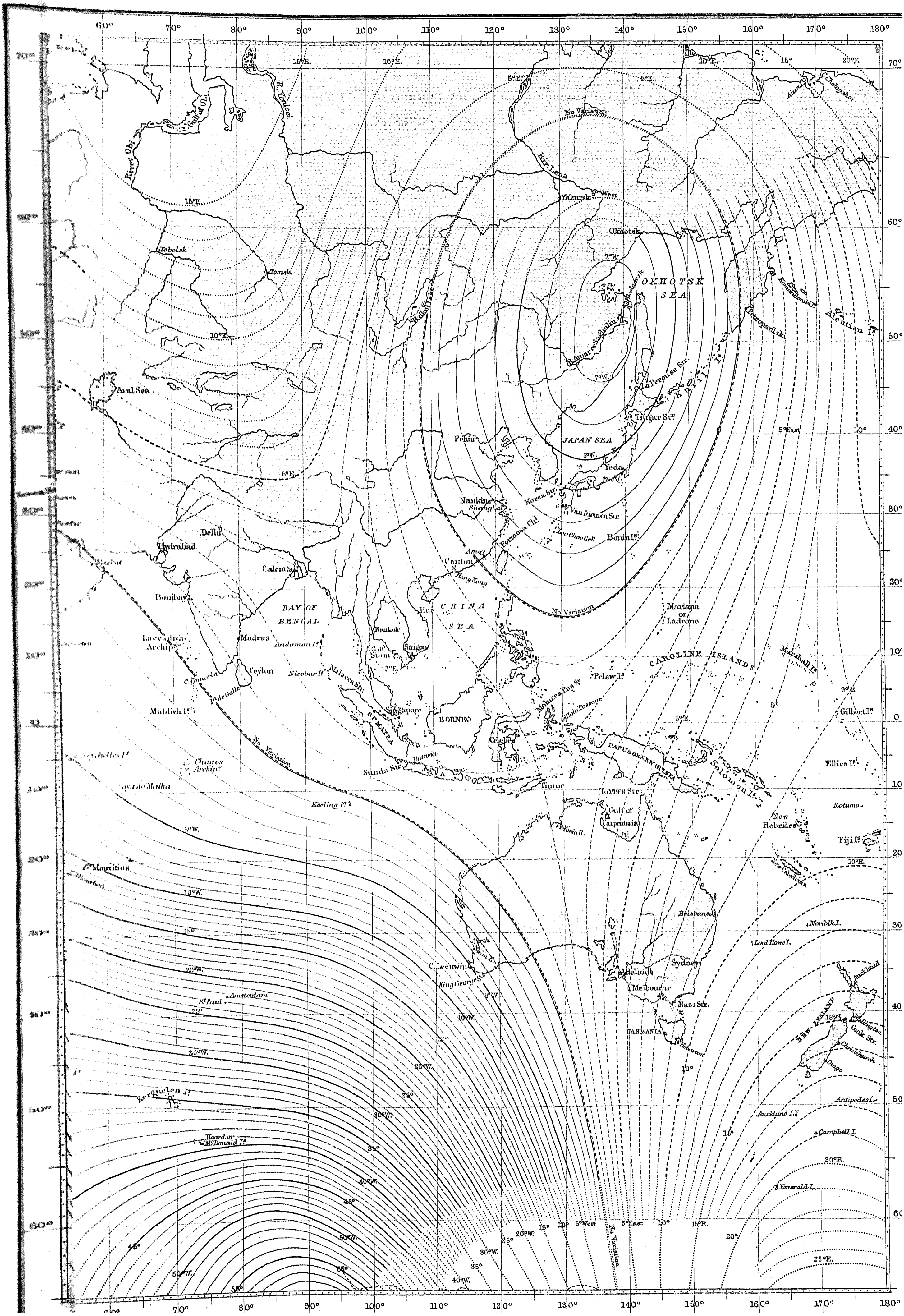
No satisfactory explanation has yet been given, and in the present instance only suggestions can be made based on the far from complete facts available.

The voyage of the Challenger has shown that, in addition to the remarkable local magnetic disturbances which have been found on the great continents, in the solitary islands of the sea surrounded by apparently normal conditions similar local disturbance is found. It has also been suggested that the magnetic portions of these islands causing the disturbance may possibly "have been raised to the earth's surface from the magnetised portion of the earth forming the source of its magnetism," and tending to prove Airy's conclusion, "that the source of magnetism lies deep."

Considering, therefore, the changes which are in progress and have taken place in ages past in the distribution of land in the world, it may fairly be conceived, not only that large changes have likewise occurred in the distribution of its magnetic portions appearing here and there on the surface and producing local magnetic disturbance, but that there are others of a more progressive character below the earth's surface which are only made manifest by the secular change observed in the magnetic elements. Although prominence is thus given to the conception that the secular change is chiefly due to continuous redistribution of magnetised matter in the interior of the

earth, it is not intended to exclude the view that solar influence may have a small share in producing the observed phenomena.

In concluding this Report it may be remarked that however subsequent research may add to, qualify, or reverse, the conclusions drawn from the observations made during the voyage of the Challenger, substantial gains have been won for the science of terrestrial magnetism, forming a sound basis for future magneticians to build upon. The labours of those who planned and started the system of magnetic observations of this voyage, as well as of those who so zealously carried it out, have borne good fruit, of which it may be reserved to others to reap the full benefit.


OKHOTSK SEA
JAPAN SEA
CHINA SEA
BAY OF BENGAL
CAROLINE ISLANDS
PAPUA OR NEW GUINEA
BORNEO
SUMATRA
JAVA
TASMANIA
NEW ZEALAND
Aral Sea
Kuril I.
Aleutian I.
Solomon I.
No Variation
Yakutsk
Okhotsk
Pekin
Nankin
Shanghai
Canton
Hong Kong
Delhi
Calcutta
Bombay
Madras
Ceylon
Singapore
Timor
Sydney
Melbourne
Adelaide
Brisbane
Mauritius
Kerguelen I.
Heard or McDonald I.
Tobolsk
Tomsk
Yedo
Bonin I.
Torres Str.
Bass Str.
Fiji I.
New Hebrides
Gilbert I.
Ellice I.
Marshall I.
Ladrone

THE

VOYAGE OF H.M.S. CHALLENGER.

PHYSICS AND CHEMISTRY.

REPORT on the ROCK SPECIMENS collected on Oceanic Islands during the Voyage of H.M.S. Challenger, during the years 1873–1876. By Professor A. RENARD, LL.D., Ph.D., F.G.S., Hon. F.R.S.E., etc., of the University of Ghent, Belgium.

PREFACE.

THE examination of the rocks which are described in this Report was commenced at the time when I became associated with Mr. Murray in the study of the deep-sea deposits collected during the cruise of the Challenger. Mr. Murray had discovered that loose volcanic materials played a very large part in the formation of the deposits of the deep sea, and it was considered desirable to institute a comparison between these and the products of the same origin in volcanic islands situated in, or on the borders of, the great ocean basins. These researches have been conducted with the object just indicated, and have led to a detailed description of the rocks placed in my hands. As this description has no direct relation to that of the deep-sea deposits, the Editor has judged it desirable to publish these researches in a separate Report, comprising especially questions relative to the lithology and mineralogy of the hand specimens collected on Oceanic Islands during the cruise of the Challenger.

All considerations of a more general order, as to the relations which these islands bear to the orography of the deep sea, will be treated of in the Report on the Deep-Sea Deposits.

I desire to thank here Mr. John Murray, Mr. J. Y. Buchanan, Professor H. N. Moseley, and Fleet Surgeon George Maclean, R.N., for all the information they have been so kind as to furnish concerning the rocks collected, and for placing their numerous specimens at my disposal.

CONTENTS.

PETROGRAPHICAL DESCRIPTION OF THE ROCK SPECIMENS.

I.—ROCKS OF TENERIFE.

Few of the volcanic islands of the Atlantic have been the object of such important geological inquiries as Tenerife. It inspired L. von Buch's theory of elevation craters,[1] and since that time it has been very often visited by geologists. A large number of scientific papers have been devoted to its description, among which one of the most important is the remarkable monograph by von Fritsch and Reiss.[2] More recently G. A. Sauer has given a detailed lithological description of the phonolites collected at Tenerife by von Fritsch.[3]

The Challenger Naturalists, on a short visit to Pico de Teyde,[4] collected some specimens, the description of which must, in the absence of stratigraphical details, be limited to a few of those mineralogical and lithological features presented by some of these rocks, that from a petrological point of view deserve to be made known.

Near Puerto d'Orotava, basaltic scoriæ are found; they are greyish-black, rough to the touch, and vesicular; the vesicles, lined with a siliceous coating, measure from 2 to 3 mm. in diameter. None of the constituent minerals can be detected with the naked eye. With the microscope crystals of augite and rare crystals of olivine appear as elements of the first generation. The rather large crystals of augite show very fine examples of polysynthetic twinning, and were it not for the colour of the section, they might, at first sight, be taken for felspathic lamellæ twinned according to the albite law. The adjoining figure (fig. 1) shows some of those elongated sections of augite. The portion marked A is sensibly perpendicular to an optical axis; the portion B extinguishes in a direction parallel to the lengthened edges. In the upper part of the figure the prismatic cleavage is seen; at other points irregular fractures are observed, like those seen in sections of sanidine. Nearly all the sections of augite are twinned as in the figure; sometimes they are broken, and the fragments have been displaced. Olivine is rather rare, and the outlines of its sections are faint; the mineral is altered into serpentine, and the cracks are filled with calcite. A great deal of magnetite is found, but larger opaque patches ought to be

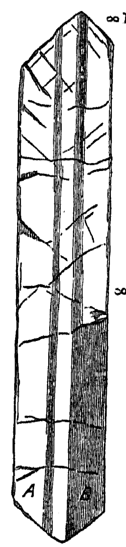


Fig. 1.—Basaltic scoriæ near Puerto d'Orotava. Section of augite with polysynthetic twinning.

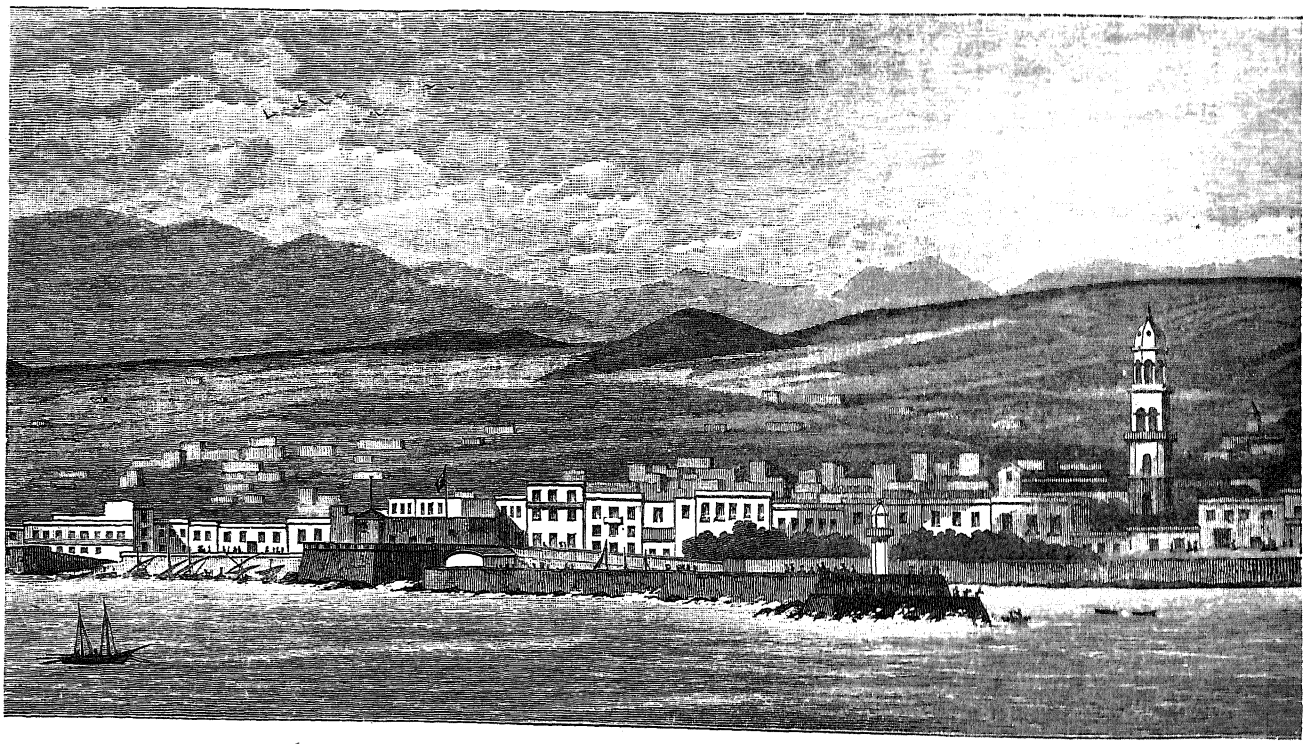
[1] L. von Buch, Physikalische Beschreibung der Canarischen Inseln, Gesammelte Schriften, Bd. iii. p. 229, Berlin 1877.

[2] Von Fritsch und Reiss, Geologische Beschreibung der Insel Teneriffe, 1868.

[3] Sauer, *Zeitschrift f. d. ges. Naturw.*, Bd. xlvii., Halle 1876.

[4] See Narrative of the Cruise of H.M.S. Challenger, vol. i. p. 53.

referred to titaniferous magnetite or to titanic iron. Crystalline outlines observed in these may be ascribed to a regular hexagon. These sections are surrounded by a zone of leucoxene, which appears brownish in transmitted, greyish in reflected, light. The ground-mass is formed by a network of small prismatic augites with rather sharp outlines; a brownish decomposed glassy susbstance is scattered between these, but this base plays a subordinate part. The almost complete absence of plagioclase, the characters of which have only been recognised doubtfully and then only in a few sections, and the predominance of augite, would tend to class this rock with the pyroxenites. The



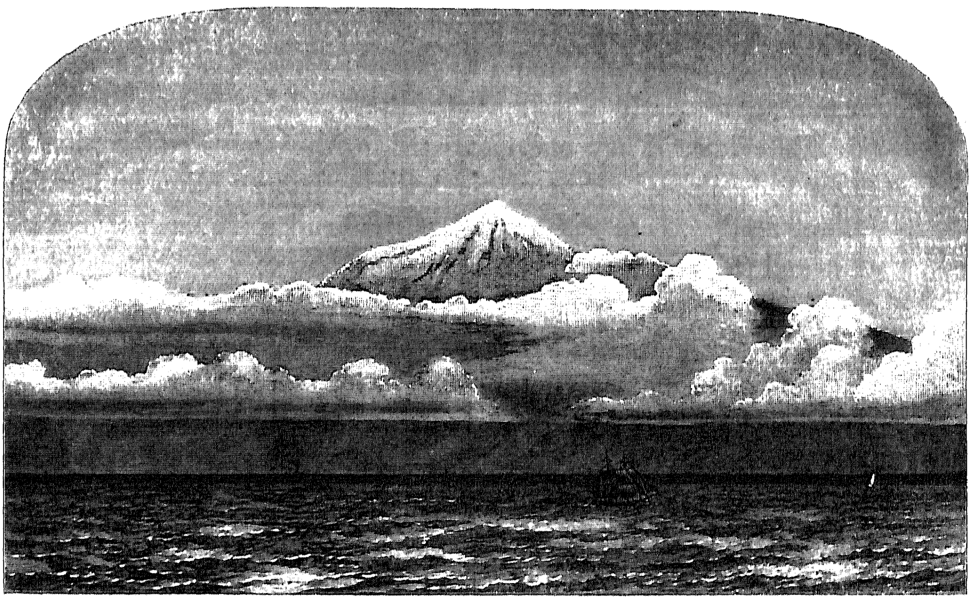
Santa Cruz, Tenerife.

presence of olivine, on the other hand, connects it with the limburgites, but perhaps this mineral is too subordinate to enable the rock to be classed in the latter group.

Near the same locality, Puerto d'Orotava, a bluish black rock is found; it is filled with small circular vesicles, measuring 2 to 3 mm.; these contain a whitish mealy matter. Its fracture is irregular, and none of the constituent minerals can be distinguished with the naked eye. The specimen in question is a basalt of the felspathic type; its microscopical structure is that of a dolerite. The plagioclase crystals are lamellar, and grains of augite more or less well crystallised are embedded between them; larger sections of olivine are also seen. The plagioclases extinguish under rather large angles; they are very probably a mixture approximating to bytownite. This felspar shows

Carlsbad twins; the two principal individuals exhibit polysynthetic striation, and their extinctions are almost always unsymmetrical. The augite shows itself with the characters which it assumes in basalts. The olivine sections have rounded edges, with a yellowish zone of decomposition; the interior of the mineral is serpentinised, this alteration being made visible by the formation of green fibres penetrating all the fissures. These sections of olivine contain a rather large number of inclusions, with outlines suggesting the form of an octahedron; these are slightly transparent with a brownish tint, and are probably picotite.

The rocks we shall now describe were found in the Cañadas, a remarkable plain covered with scoriæ and shut in on nearly all sides by a perpendicular wall of basaltic



Peak of Tenerife from the N.W., 40 miles.

rock. The present terminal cone of the mountain rises from this vast plain. The Cañadas represent an ancient and much larger crater, in the centre of the remnant of which the more modern smaller peak has been thrown up.[1]

A rock collected at the foot of the Cañadas is a basaltic scoriæ, the vesicles reaching a diameter of 5 to 6 mm.; it is covered with limonite, and a freshly fractured surface shows a compact violet mass. Under the microscope it is seen to be very much altered; its structure is sometimes that of dolerite or that of ordinary basalt. The plagioclase also shows all the transitions from rather large and twinned crystals to the microliths of the paste, which appear as small striæ, and in which the polysynthetic lamellæ can

[1] Narr. Chall. Exp., vol. i. p. 55.

with difficulty be detected. The augite is decomposed; it is yellowish on its edges, the centre still remaining rather violet. The olivine is also altered, being reduced to an external zone, where only the outline of the mineral can be seen. The interior of the section is filled with trichites having a pretty regular disposition and showing rectangular forms; they are associated with small reddish particles. Certain parts only of the olivine polarise, but the colours are not very brilliant. Perhaps we have here an hyalosiderite; this at least seems to be indicated by the great number of trichites, which are also developed in the vitreous decomposed mass forming the ground-mass.

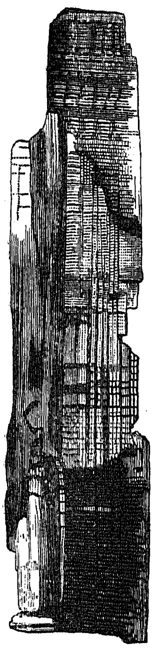


Fig. 2.—Augite-andesite, Cañadas. Section of plagioclase crossed by two series of polysynthetic striæ.

Some other specimens collected in the Cañadas have a waxy appearance when broken, a black colour shading into yellowish brown, with an irregular fracture and containing rather large crystals of sanidine. With the microscope a ground-mass is seen formed by small plagioclases, perhaps also by microliths of sanidine, and by some subordinate vitreous matter. Large sections of plagioclase and of sanidine stand out in this mass. The former show nearly always both the Carlsbad twinning and that of the albite law. They are elongated, with very small extinctions, and ought to be classed in the plagioclastic series near oligoclase and andesine. As frequently occurs with andesine, the hemitropic striæ are exceedingly close and thin. The sections are crossed by two series of polysynthetic striæ; these two systems cut one another under sensibly straight angles, and in polarised light give the section the aspect of microcline, as can be seen in the adjoining figure (fig. 2), only the small veinules of albite are here missing. In some cases these striæ are so faintly visible, that the section might be mistaken for sanidine, but the plagioclastic striæ, be they ever so feebly marked, ought to set aside that interpretation. Sanidine is found in the rock in the form of irregular sections, of rather large size, and twinned according to the Carlsbad law, with the characteristic fissures of that felspar. It can be seen by the undulating extinction that these crystals, like those of plagioclase, have been subjected to mechanical deformation, which altered the optical properties, and renders any subsequent determination difficult. The presence of augite as crystals of the first generation is also ascertained; its pleochroic sections have often indistinct outlines; they are corroded and invaded by the ground-mass. Some small prisms of apatite are also observed, which show, in addition to the usual faces of the prism, a truncation on the edge $OP/\infty P$; they are terminated by the pinacoid OP. Magnetic iron is rather frequent; small hexagonal hardly transparent lamellæ are also seen, which may be referred to titanic iron. We have stated that the ground-mass is formed by the accumulation of small felspar crystals; these are of two types. Those of the first type are tabular, with less distinct outlines, and larger sections; those belonging to the second type are

lamellar, their extinction taking place under very small angles, the crystals frequently showing twins without repetition; in short, all seems to indicate that their index of refraction is higher than that of the tabular felspar. The ground-mass reacts like annealed glass between crossed nicols, the tints being hazy. It is uncertain whether these phenomena are to be ascribed to contraction or to pressure which may have acted on the isotropic substance and caused its devitrification. This rock ought to be classed with the pyroxenic andesites containing sanidine, a type related to the trachytic series.

Another rock from the Cañadas is bluish grey, with an irregular fracture; it contains small vesicles with a homogeneous aspect, speckled with black granules. Examination of microscopic slides shows that the rock is a felspathic basalt. The plagioclases, of which numerous sections are seen, have very large lamellæ, and their extinctions are those of labradorite; the augite and the olivine have generally rounded outlines, the latter mineral being decomposed. With these minerals are associated grains and crystals of magnetite, which are rather numerous, and very elongated and truncated prisms of apatite. The ground-mass is formed of a vitreous matter, which is undergoing alteration, as shown by the phenomena of chromatic polarisation it exhibits.

Lastly, a porphyritic lava was collected in the Cañadas. This rock is black, massive, finely grained, scoriaceous, has an irregular fracture, and contains porphyritic felspar crystals. Microscopic examination shows that it has a vitreous base, with very distinct traces of fluidal structure. Crystals of augite, felspar, hornblende, and black mica stand out of the ground-mass, and give the rock a microporphyritic structure. The felspar crystals are twinned according to the albite law, these plagioclastic lamellæ being embedded in two principal individuals twinned according to the Carlsbad law. The separation between the two individuals is clearly marked only on a portion of the length of the section; in several places there is an irregular interpenetration of the two halves. Interposition of biotite scales in the plagioclases can occasionally be ascertained. The same mineral is found as inclusion in augite, as shown in the adjoining figure (fig. 3). The crystals of augite are distinctly prismatic and of light greenish tint, hardly pleochroic. Hornblende is not abundant; its sections are often irregular, sometimes they are aggregated, or form groups. They might be taken for twinned crystals, but there is only a simple juxtaposition; indeed, the lines of cleavage of adjoining sections never follow the direction they would do in the case of true twin crystals. The rays parallel to a are of a pale yellow colour, those parallel to β are reddish. The most characteristic mineral of the rock, and the most widely distributed, is without doubt biotite; sections cut parallel to the base are very frequently observed; these lamellæ are very pleochroic, the rays vibrating perpendicular to a being of a pale yellow

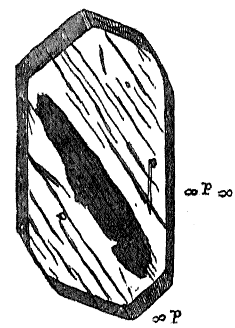


FIG. 3.—Augite-andesite, Cañadas.

Section of augite with biotite lamellæ parallel to a prismatic face.

while those parallel to β are almost black; the shape of these sections is nearly that of elongated parallelograms. This mineral is generally well crystallised; some sections perpendicular to the lamellæ are hexagonal, two of the sides being very elongated, the other much smaller, and the presence of the latter shows that the biotite has crystallised in this rock with pyramidal faces but little developed, truncated by the pinacoid OP. The lamellæ parallel to this last face remain dark through a complete rotation between crossed nicols, and in convergent light show a black cross. Sections of magnetite are wedged into the sides of the biotite, which sometimes appears to be altered, and in that case magnetic iron surrounds the decomposed sections. This association appears to show that the magnetite might very well have been derived from the alteration of biotite. In the ground-mass, small plagioclases predominate; these often assume a radial spherulitic arrangement which is repeated with a certain constancy. This rock might be classed among the micaceous augite-andesites.

A rock collected in the middle of the Cañadas is a basalt; it is massive, with more or less nodular blackish grey fracture; it does not show any macroscopic minerals. Under the microscope it is seen to be made up of plagioclase, rather large and irregular sections of olivine, and little crystals of augite; some black mica is also present.

A rock from the top edge of the Cañadas has a compact appearance and is blackish in colour; with the naked eye very elongated crystals of sanidine, embedded in a homogeneous mass, are to be seen. Microscopic examination shows a ground-mass composed of small microliths of felspar more or less radiated, large sections of prismatic and colourless felspar, whose sharp outlines stand out clearly in the surrounding mass. These microporphyritic sections are twinned according to the Carlsbad law, and ought to be referred to sanidine; plagioclastic striæ are never to be observed; the trace of the composition plane divides the section from end to end without ever deviating from a straight line. The usual fissures of sanidine traverse both the twinned individuals as if they formed but one. The extinction of these crystals may be noted here:—Sometimes a section with sharp outlines shows the trace of the twinning reduced to a simple line, in which case it may be assumed that the section is cut nearly perpendicular to the plane of symmetry *v. z. l.* in the zone $P:k$; the extinction of these sections shows that one of the individuals extinguishes nearly always in a direction parallel to the trace of the twinning, and the other at a greater or less angle. Sections, which do not show this sharpness of outline and the trace of the composition plane, ought to be considered as cut obliquely to the zone $P:k$. In this case, if the extinction angles are large and symmetrical, the section is in the zone of the prism; if, on the other hand, they are unsymmetrical and the angular difference very large, it is probable that the section is in the zone $P:M$ of one individual, and in the zone $P:x$ of the other, *i.e.* in a zone in which the extinction of one of the individuals increases but slightly (zone $P:M$), and that of the other rapidly (zone $P:x$). If the extinctions are very small it tends to

prove that the section is in a zone intermediate between the preceding $P:M$ and $x:M$. The determination of the angles of extinction, measured from the trace of the twinning of these crystals, shows that nearly all these felspars have lain parallel to each other in a plane, and that the sections have been cut very nearly perpendicular to the plane of symmetry, inclining slightly to the zone $P:M$. The following extinctions have been measured for the two individuals (left and right) :—

Left	Right
0°	5°
0°	7°
0°	13°

These crystals of sanidine are embedded in a finely granular ground-mass containing small lamellar felspars, which may also be considered as belonging to sanidine. These microliths are arranged in tufts, and are associated with very small greenish prisms belonging probably to hornblende. It is seen by the deposit of oxide of iron that the basis of the rock is altered; it was perhaps formerly of a glassy nature.

In the gulleys to the west of Fuente Pedro, a spring situated at the height of 3500 feet, a greyish rock speckled with prismatic crystals of sanidine was collected. This rock has a plane fracture, a waxy lustre, and is very like a phonolite. Microscopic examination shows that the ground-mass contains microporphyritic crystals of sanidine and of plagioclase, which are almost microliths, passing into those constituting the paste; augite and magnetite appear in rather large sections, probably owing their origin to the decomposition of the hornblende. The sanidine sections are large, but their outlines are not sharp; those of the plagioclases, on the other hand, are well defined, notwithstanding the mechanical deformations to which they were subjected. The sanidine shows the characteristic fissures of this mineral, and is twinned according to the Carlsbad law. The deformations produced in this felspar by mechanical action have rendered it fibrous at the extremities of the sections; many of the crystals are bent and broken. A fact that must also be ascribed to these deformations is that the sections show not only undulating polarisation but also deeper colours of chromatic polarisation. Where these phenomena of pressure are observed, instead of seeing the usual pale blue tints of sanidine, the colour is darker; it passes to an indigo tint of marked intensity. We are led to think that this accentuation of tint is caused by mechanical action, which has left its impress on all the constituent minerals of this rock. The crystals of plagioclase are far more numerous than those of sanidine; they are smaller, more elongated, and bent in all directions. These deformations, which are repeated in a marked way in all the sections of plagioclase, are accom-

panied by irregular fractures more or less perpendicular to the length of the crystal (see fig. 4). Augite can only be recognised in the larger crystals; these alone have withstood the pressure. This mineral is polysynthetically twinned; it is generally in a fragmentary condition, filled with fissures. Isolated hornblende cannot be found, but some rather large patches of magnetite surround the small sections of hornblende, forming a kind of zone, and accompanied by very small scales of biotite. This seems to show that the hornblende, once present in the rock, has been replaced by these two minerals. We ought also to mention a mineral playing a rather important part in this rock, sodalite. It is seen in hexagonal or quadratic colourless sections. They are of primary consolidation, as is shown by their forming a centre of aggregation for small crystals of plagioclase, disposed as spherulites round the sodalite. With the condenser a black cross is rather faintly indicated; they cannot be mistaken for nepheline or any other hexagonal mineral, because between crossed nicols all the sections remain obscured. The presence of sodalite in this rock is not an exceptional fact; it is known that this mineral is found in trachytic rocks associated with sanidine and augite, in nearly the same conditions as those we have mentioned. The ground-mass is formed by a network of plagioclase crystals and grains of augite. The rock has a doleritic structure, its mineralogical composition classing it among the augitic andesites, closely allied to trachytes.

FIG. 4.—Augite-andesite near Fuente Pedro. Crystal of sanidine and small crystals of plagioclase, bent and fibrous in the ground-mass.

In the same gulleys of Fuente Pedro a whitish altered rock similar to the preceding was collected. The ground-mass is nearly homogeneous, and contains irregularly disseminated grains of felspar; the fracture of the rock is irregular. Under the microscope the following microporphyritic minerals can be seen: plagioclase, sanidine, augite, and hornblende. Some sections of plagioclase have exceedingly thin polysynthetic striæ over the whole surface. Others show the Carlsbad twinning, and also that of albite; and lastly, some show in addition the periclinic striation crossing the albitic lamellæ. It is rather interesting to notice that, when the sections show the Carlsbad twinning, one of the two halves presents the polysynthetic lamellæ of the albite law, and the other half shows both the albitic and the periclinic striation. This phenomenon tends to prove that these plagioclases have crystallised also according to the Carlsbad law. Indeed, if we bear in mind that the periclinic lamellæ ought to be seen in sections parallel to x, and never in those parallel to P, and that in a Carlsbad twin the faces x

and P, for the two individuals, are placed side by side, we must admit, in order to explain the fact just mentioned, the existence of a Carlsbad twin: sections parallel to P are also parallel to x, and can only show periclinic lamellæ in the individual of which the face x has been cut. Symmetrical extinctions measured in the zone $P:k$ have given, for several cases, values of about 5°; the sections showing the periclinic striæ extinguish at angles of 12° to 14°. This seems to show that we are dealing here with an isomorphous mixture approaching that of oligoclase. There are also small sections of felspar, the physical characters of which contrast with those that we have just described. They are more corroded, have less regular outlines, and are crossed by fractures; polarised light shows that they have crystallised according to the Carlsbad law, and do not show the polysynthetic striæ. The angles of extinction are usually rather large, but at the same time it is noticed that the outlines are feebly marked; this shows that these sections belong to a zone intermediate between the zones $P:M$ and $k:M$, closer to the latter. The frequency of these larger extinctions would prove that this felspar is more developed in the direction of the vertical axis than in the direction of the edge P/M. The crystals of hornblende have a very broken appearance, and are greatly elongated. One cleavage predominates, and irregular fractures are observed nearly perpendicular to that direction; these fractures are caused most likely by mechanical action due to the contracting mass, giving rise to deformation in all the constituent minerals of the rock. The polarisation colours of the hornblende sections are orange, and show that decomposition is taking place. Extinctions of 4° or 5° have been measured; pleochroism is very marked.

γ	>	β	>	α
dark brown		yellow brown		pale yellow

The sections perpendicular to the axis c are very rare and ill-defined, as may be expected from the very prismatic form of hornblende in this rock. Augite is more plentiful than hornblende; it is elongated like the latter, and often shows twinning according to the usual law; sometimes the sections are polysynthetically twinned, symmetrical extinctions on both sides of the twinned lamellæ measured 38°. This augite is not pleochroic; yellowish spots are seen in the interior of the section, indicating incipient decomposition. Like the hornblende, this mineral often shows fractures and crevices caused by mechanical action. Numerous grains and crystals of magnetite are often accumulated in certain points. The ground-mass is composed of an aggregation of small elongated felspar crystals, interwoven in all directions, and very small augitic sections are wedged between them. The felspar microliths ought to be ascribed, like the microporphyritic individuals, to sanidine or to a plagioclase with small extinctions, twinned according to the Carlsbad law and that of albite. The small felspars of the ground-mass, which we also ascribe to sanidine, show the Carlsbad twinning without any trace of plagioclastic striæ. The features of the

small sections of augite in the ground-mass ought to be mentioned. We have already stated that both this mineral and hornblende show traces of deformation by mechanical action. The augitic microliths have been crushed, they have become somewhat fibrous, and taken the appearance of uralite; this fibrous structure may be nearly always connected with the bends and fractures which are observed in the mass. The little augite prisms are often bent and broken at the top of the curve. The broken portions have become displaced, and the space between the two fragments is filled with fibres which connect the disjointed portions. The greenish substance scattered in filaments between the felspathic microliths of the ground-mass is probably nothing but crushed and stretched out augite. Under the high powers of the microscope, very small scales with extremely sharp hexagonal outlines are observed; these lamellæ have a certain thickness so as to enable the edges of the prismatic zone and of the pinacoid to be seen. In other cases they are more irregular and scattered all through the mass of the rock. At first sight they might be taken for red hematite, but their colour is rather greyish violet than red. This colour recalls that of lamellæ of titaniferous iron as observed in some phyllites of the Ardennes. We consider these small hexagonal sections to be the same mineral; it can be ascertained that they are monaxial. The rock which we have just been describing ought to be referred to augite-andesite, but the presence of hornblende and sanidine make it a transition form to the trachytes.

On the path to the Peak, another rock was collected with a massive ground-mass, black in colour, of basaltic appearance, containing large vesicles, some of which have a thin coating of a zeolitic or siliceous substance. This rock ought to be classed as a dolerite. Under the microscope the ground-mass is seen to be formed of small plagioclase lamellæ, between which are scattered microscopical crystals of augite. In the ground-mass are crystals of augite and olivine of the first generation. Generally the felspar is less developed in large crystals; the olivine often shows sections very well defined on a part of the outlines, which at other parts are broken up and corroded. It does not seem probable, if we are to judge by the fluidal structure of the ground-mass around the crystals, that this corrosion has been produced by the action of the magma; possibly the olivine was already in a fragmentary state before the last movements of the magma, which preceded the solidification of the rock. The olivine is rather altered, and is bordered by a yellowish zone which penetrates the interior of the sections. The smallest crystals of this mineral are quite decomposed; they appear as yellowish grains, and their nature can only be made out by following all the phases of alteration between the larger sections, with corroded outlines, and these microscopical individuals. The olivine, as also the altered augite, contains trichitic skeletons and crystals of magnetite. Another somewhat common mode of decomposition has been observed in this mineral; it is shown by a fibrous structure, the

fibres lying parallel to the axis *c*. The felspars belong to two types; one of these is lamellar, the other occurs in short prisms. The latter, generally, have less numerous plagioclastic lamellæ than the former, and the angles of extinction are large. These plagioclase sections generally show a large individual, in which are one or two hemitropic lamellæ, the thickness of which is very small compared to the size of the section. Some crystals of albite and of anorthite have the same peculiarity, and in this case the extinctions seem to indicate that the felspar may be anorthite. The lamellar felspar, on the other hand, judging by the extinctions, seems rather to be labradorite. These plagioclases do not kaolinise; when altered they appear of a milky colour and slightly granular. With polarised light they remain dark or assume a very faint bluish tint. Perhaps this modification is a transition to a zeolitic substance, the nature of which it is difficult, if not impossible, to ascertain. The augite has the ordinary characters of that mineral in doleritic basalts. The grains are generally wedged into the triangular space formed by the inter-crossing of the lamellæ of plagioclase. When decomposed, its violet colour is weakened. The vitreous base, rather distinct patches of which are found around the augitic microliths, sometimes forms a narrow and colourless zone, surrounded in turn by an isotropic rim of a light brownish colour, filled with a blackish globulitic granulation. The existence of these zones may be explained if we bear in mind that when the augite crystallised the surrounding parts of the magma gave up their metallic pigment to the crystal that was being formed, and so the first zone was necessarily discoloured. The darker external vitreous zone may be considered as a residuum of crystallisation richer in metallic oxides; these have often become isolated, assuming the globulitic form. As we have already stated, this rock belongs to the felspathic dolerites with a vitreous base.

Below Casa Blanca a brownish rock was collected; it is earthy, with an altered appearance, has an irregular fracture, is fine grained, and contains tabular crystals of sanidine measuring 3 to 5 mm. Microscopic sections show a ground-mass composed of lamellæ of tridymite with a faint yellow colour. Rather large sections of felspar and augite can be distinguished in it; this latter mineral is frequent in small sections embedded in a tridymite mass. Two kinds of felspar are to be seen; some lamellæ have small extinctions like those of oligoclase, which is known to occur in the older rocks containing orthoclase and quartz. The other felspathic sections are those of a monoclinic felspar; they have irregular and indistinct outlines, and never show polysynthetic striation, but they are twinned and composed of two individuals. The outlines of these sections and their extinction show that this felspar is twinned according to the law of Manebach; these sections show, like sanidine twinned according to the Carlsbad law, two halves joined together, but, whereas in a Carlsbad twin, the direction of

cleavage remains the same for both individuals in the section, with the twin of Manebach each individual has its cleavages, ending at the line of the composition plane, forming an angle of about 66° with one another. One of the two better marked lines of cleavage belongs to the trace of P (composition plane). The other, less marked, is the prismatic cleavage. The two halves of the sections extinguish symmetrically at an angle of about 7° ($A\ A'$), the extinction being positive (see fig. 5). These details show that this mineral is sanidine. In some cases it has crystallised according to the Carlsbad law. The augitic sections are greenish, and they are not very common. The ground-mass contains augite microliths embedded in lamellæ of tridymite. Under low magnifying powers it might be fancied that the rock possesses perlitic structure or contains trichites, but under higher powers it is ascertained that these indistinct forms and lines are extremely thin lamellæ, superposed one upon the other or imbricated as in the case of tridymite. The hexagonal outlines of these lamellæ are shown by rather distinct traces, rendered slightly more apparent by a brownish coloration due to limonite. This fact is analogous to what is often observed for tridymite in other eruptive rocks, and in some meteorites. Generally the scales in question are well outlined; in other cases they are, as it were, slightly notched. Their optical properties cannot be studied on account of their extreme thinness and their superposition. All that can be said is that the colours of polarisation are faint, and similar to those of quartz in sections of the same thickness as that of the tridymite.

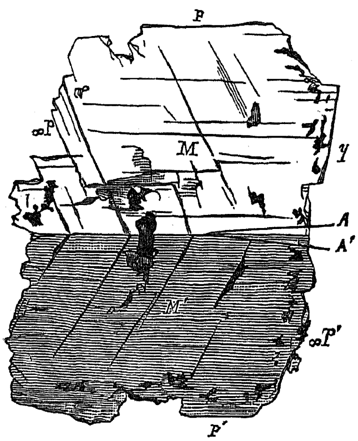


FIG. 5.—Altered rock below Casa Blanca. Section of sanidine twinned according to the Manebach law.

Other specimens collected on the same excursion to the Peak are augite-andesites, more or less scoriaceous, and felspathic basalts with or without vitreous base, often globulitically devitrified. These rocks do not present any character which was not mentioned in the basalts described above. Several specimens of obsidian were also collected, with alternate black and greyish bands, often more or less fibrous, on account of the elongation of the pores. A striped and fibrous obsidian exactly resembles pumice, except that in the former there are massive portions. These obsidians are rich in trichites of various forms, which are more numerous the fewer minerals the rock contains. Among the latter may be noticed plagioclase, hornblende, augite, and magnetite. Small felspar lamellæ are seen in the vitreous mass, straight or slightly crescent shaped, indented at the two ends. The pumice collected does not show any difference from the obsidian except in structure. It has a light greenish tint, and a silky appearance. No minerals can be distinguished by the naked eye, but with the microscope felspar, hornblende, augite, and magnetite can be seen.

II.—ROCKS OF THE CAPE VERDE ISLANDS.

A. *Rocks of St. Vincent.*

The archipelago of Cape Verde consists of eight large islands, two of which, St. Iago and St. Vincent, were visited by the explorers of the Challenger; they also landed at Bird Island, one of the islets of the group situated near St. Vincent. We shall examine first the rocks collected on the last-mentioned island, which is essentially of a volcanic character, presenting an arid and desert aspect. The hills around Porto Grande are formed of igneous rocks, of which each of the superposed beds do not attain a metre in thickness. These sheets are slightly inclined, their dip increasing as they recede from the port. They are frequently traversed by vertical dykes of basalt, of which the general directions are N.-S. and E.-W. These injected basalts show a columnar structure perpendicular to the sides of the rocks traversed. This prismatic structure is also found in the beds of the rock constituting the principal mass of the hill. At the contact of the intrusive rocks with the beds which they traverse, both are much decomposed and disintegrated,—the latter being partially converted into a substance resembling kaolin. As these veins traverse the hill from base to summit, and offer more resistance to denuding agencies, they remain as walls of rock crowning the heights with a jagged outline which is very characteristic.[1]

According to Professor Doelter,[2] the history of this volcano may be sketched as follows. St. Vincent is the ruin of a strata-volcano of which the height was considerably greater than the crest of that part of the crater now remaining. It is difficult to determine the exact dimensions and the position of this ancient crater; it appears, however, probable that it must have been situated within an area at present comprising the port, the undulating ground, and the plains which extend behind Porto Grande. Erosion and the action of the waves have produced such profound modifications of the surface, that it is scarcely possible to indicate exactly the original form of the volcano. It appears to have been formed on a land surface of considerably greater extent than the present island, as indicated by the hills formed of eruptive rocks of ancient type (diabases, syenites), the age of which it is difficult to determine with precision. On the south-west side of this great volcano, which is characterised by sheets of lava, and occasionally by tufas traversed by numerous dykes, a considerable number of secondary craters have been formed, that do not appear to be of ancient date. The presence of somewhat recent calcareous beds, which are spread out on the slopes of Monte Viana and at other points, especially on the north shore,

[1] Buchanan, On geological work done on board H.M.S. Challenger, *Proc. Roy. Soc.*, vol. xxiv. p. 612, 1876.

[2] Doelter, Die Vulkane der Capverden und ihre Produkte, p. 44, Gratz, 1882.

indicate that the volcano has been affected by a movement of elevation since its formation.

In the specimens which we have examined we have not found any of the rocks of ancient type mentioned by Professor Doelter in the passage above alluded to. All those collected by the Challenger belong to recent volcanic rocks, which we shall now describe; they come from localities not far from Porto Grande.

We shall first describe the specimens from the dykes, which traverse sheets of lava. They are basalts presenting the microscopic characters of that lithological type. One of the specimens is a dolerite; under the microscope sections of olivine of small size and lamellæ of felspar are seen enclosing grains and crystals of augite. The sections of plagioclase show the characters of the felspar of the basaltic rocks. The same may be said of the augite. Generally the latter mineral is in sections with irregular outlines, in other cases it is seen in the form of intercrossed groups. The augitic sections showing these groupings in our preparations were not cut so as to allow of estimating exactly the angle at which the twinned crystals were joined, or of determining the law of twinning; but their aspect resembled sufficiently that of the twin of augite according to an acute pyramid, which has been observed macroscopically by Vrba, and of which Professor Becke has indicated the presence in microscopical specimens. These augitic sections are also twinned, following the ordinary law parallel to $\infty P\infty$. The olivine is not microporphyritic; it is seen in small sections often lozenge-shaped, with a centre of the same form of which the sides are parallel to the outlines of the section. It is often yellow by decomposition; and disposed in the mass of the rock so as to contribute to its doleritic structure. Small scales of biotite are occasionally seen; sections of magnetite, on the other hand, are numerous. Finally, a small quantity of a yellowish fibrous matter is found amongst these minerals, which, it appears very probable, was originally a vitreous substance.

Another basaltic rock, forming a dyke and covered with zeolitic incrustations in which may be observed isolated crystals of chabasite, must, like the last mentioned, be referred to the felspathic basalts; it contains crystals of augite visible to the naked eye. In the ground-mass, formed of a colourless base with microliths of augite and felspar, crystals of the same minerals but of a larger size are seen associated with olivine and magnetite. The augite is generally perfectly crystallised; the pleochroism and absorption are—

$$\gamma \text{ and } \beta \text{ purplish} > \alpha \text{ pale yellow.}$$

With respect to the plagioclase, the extinctions on the face *M* are negative and about 27°; for two adjacent hemitropic lamellæ symmetrical extinctions are seen with the maximum value 34°, which brings this felspar very near to anorthite. These plagioclases have often crystallised according to the albite law, and at the same time show the Carlsbad twinning. The presence of the latter twin may even be recognised

on the sections more or less parallel to *M*. These sections are then divided in two parts, and show two series of cleavages, which join each other at an angle of about 52°; a third cleavage parallel to the junction may also be observed. It is probable that the crossed cleavages correspond to the traces of *P*, and those of the less perfect cleavage to the traces of the prism. These facts would seem to prove that the two twinned crystals are joined parallel to a face of the zone $P:k$. The olivine shows sections which are entirely transformed into red hematite, but in which the form of the outlines and the cleavages are clear. The latter are observed in the greater number of sections to run parallel to the base; they are traversed at right angles by less distinct lines, which would correspond to the prismatic cleavage. In symmetrical hexagonal sections the acute angles are about 80°, which would correspond to the faces of the dome *k*. It is observed that sometimes these sections are surrounded by a very distinct zone of a quite colourless glass.

A rock coming from a dyke at the south-west of the island is an augitic andesite, rather rough to the touch, vesicular, in which may be seen with the naked eye plagioclases and altered crystals of augite; zeolites have formed in the cavities. The rock is altered like most of those collected in this island. The mineral which plays the part of microporphyritic element is the plagioclase; it is always rather rare, occurring as large isolated crystals, in which case its outlines are deficient in sharpness; they might be said to have been blunted by the action of the magma. This mineral has crystallised according to the Carlsbad and albite laws; it contains numerous vitreous inclusions. The ground-mass is composed of small lamellæ of plagioclase and very numerous microliths of augite having a peculiar colour; these have a slightly bluish tint, and are very decidedly pleochroic; this property is observed principally in the sections parallel to $\infty \mathrm{P\!\!\!\!\;\!R} \infty$: in these the rays vibrating perpendicularly to the length are the darkest. Considering the minuteness of these microliths, often very thin, and their pleochroism as well as their peculiar tint, they might be considered at first sight as allied to hornblende; but we have observed extinctions which exceed 40°. In transverse sections, more or less perpendicular to the axis *c*, it is seen that they are tabular in the direction of one of the vertical pinacoids. This rock is silicified; the silica penetrates into all the interstices, and covers the crystals of augite and felspar with a layer of chalcedony. This substance is distinguished from the zeolites, rather common in these rocks, by a more intense chromatic polarisation, by more decided concentric zones, somewhat similar to the zonary structure of the agates, and by the radiating fibres, which are very sharp, fine, and acicular.

Some specimens were collected on the road which leads to the summit of Green Mountain, an eminence of volcanic origin 2482 feet in height. One of these rocks is a tufa in which rather numerous small scales of black mica are seen by the naked eye.

Under the microscope these scales show two optical axes of a very small angle; the sections where the lamellæ are seen superposed are pleochroic, showing a yellow tint for the rays parallel to the scales, and a brownish one for those perpendicular to them. Irregular cracks appear on the scales parallel to *OP*. In general this mineral is much altered. It is associated in the same rock with pretty large fragments of augite and olivine; the former are cracked and of a greenish colour. These different minerals are grouped in an irregular manner and mingled with microscopic lapilli. The mica often forms small groups. This heterogeneous assemblage of minerals leaves the impression that the rock is of clastic origin.

A reddish brown spongy lava of basaltic nature containing zeolites is nearly allied to the tufa of which a short description has just been given. This lava, like the tufa, contains black mica and augite; the latter mineral is granular; more rarely its sections possess regular outlines with traces of twinning. This is almost the only microporphyritic mineral. The alteration of the rock is seen by the little lamellæ of biotite which take a reddish colour from the deposit of ferric oxide. These micaceous sections are pleochroic, and present, with regard to their physical properties, some analogy with those of the preceding rock. The ground-mass is formed of a vitreous base, in which there are to be observed numerous plagioclastic lamellæ of rather small size, entirely transformed into zeolitic matter. With these plagioclases are associated small crystals of augite. In certain cavities between the crystals just mentioned a layer of greenish substance has been deposited; it is more or less mammillated on the surface, resembling delessite, and is probably derived from the decomposition of a bisilicate. Amongst the minerals of secondary origin may be mentioned zeolitic masses which fill the small cavities of the rock with fine fibro-radiated needles. These zeolites are often covered with or accompanied by a deposit of ferric oxide. The tufts of zeolites are formed of small very elongated prisms with straight extinctions, often thinning at their point of insertion, and thickening towards the summit which advances to the opening of the little drusy cavity. This summit is often terminated by an obtuse pyramid, or else it has the pinacoid *OP*. The sharpness of these little prisms, their aspect, their localisation, and their clearly marked character of rhombic minerals, can leave no doubt as to their identification with the minerals of the zeolite group, and they might, from their crystallographic characters, be placed with natrolite or brevicite.

Finally, we have to mention a blackish rock, studded with more or less circular zeolitic points and with large crystals of augite. Under the microscope its aspect resembles kersantite in a striking manner; lamellæ of plagioclase, associated with a mineral which might be taken for biotite, are seen. But in observing the extinctions of these brown lamellar sections it is perceived that they do not extinguish parallel to the length, but at an angle which attains on an average 10°. This mineral must therefore be hornblende; hexagonal transverse sections are seen. In the very elongated sections,

which are common, the pleochroism is strongly marked; the brown tint is darker for the rays parallel to *c*, it is yellowish brown for those perpendicular to that direction. The larger felspar crystals are generally much altered; the hemitropic lamellæ are scarcely visible. In certain cases these crystals are filled with secondary products, amongst which calcite may be distinguished; perhaps this mineral is associated with scales of mica, or of quartz, or secondary felspar. The felspathic crystals of secondary formation, which are scattered throughout the mass, are much more decomposed than those of the first generation. They extinguish at rather small angles, which would seem to refer them to oligoclase. These small plagioclase crystals occur rather often in the form of a cross; probably we have here to do with a twin analogous to that of Baveno. The sections of augite are large and rather rare; this mineral is here seen with the ordinary characters which it presents in basalt. It is difficult to determine the ground-mass, as it has been invaded by products of decomposition; calcite has been developed in certain cavities. If we take into consideration its mineralogical composition, and if we set aside its structure, which is exceptional, this altered rock might be classed with the amphibolic andesites.

The harbour of St. Vincent is surrounded by a circle of heights formed of eruptive rocks; at its entrance there are isolated rocks, which may be considered as having been formerly attached to the chain of hillocks terminating at the coast. These rocks are called Bird Island; they are covered up to high-tide mark by a wide border of calcareous incrustations consisting of corallines. We have examined a specimen coming from this islet; it is a somewhat fibrous lava, which may be classed with the pyroxenites,[1] and is very closely allied to the basalts. It has the appearance of a basaltic rock; the very elongated crystals of augite visible to the naked eye are ranged parallel to each other. This disposition determines an almost fibrous structure in the rock, all the vesicles being stretched in the direction of the elongation of the pyroxenic crystals. With the microscope it is ascertained that the felspathic element is not present, and that this lava is essentially formed of augite. Some crystals of that species are porphyritic, as has just been said, others are microlithic. The large crystals of pyroxene present remarkable peculiarities, as is shown by their microscopical examination. They assume a lengthening quite unusual for this species; they may attain a length of 7 to 8 millimetres, with a breadth of 0·1 mm. On following one of these sections of augite in all its length under polarised light, it is seen that it extinguishes simultaneously between crossed nicols; it is therefore a single crystal which extends from one end of the section to the other.

[1] Doelter, *loc. cit.*, p. 187.

B. *Rocks of St. Iago.*

St. Iago is one of the most remarkable islands of the Cape Verde archipelago. It was explored by Darwin[1] during the voyage of the "Beagle," and more recently by Professor Doelter.[2] Our observations having been confined to a few specimens collected near Porto Praya, we shall restrict ourselves to the description of these rocks, referring for further information to the works of Darwin and Doelter. We shall merely state that the part of the island where the rocks were collected of which we are about to give the analysis, constitutes a natural division of St. Iago,[3]—a plateau which stretches from Pico d'Antonio to the sea. This plain is formed of lavas slightly inclined, and pierced by more recent eruptions. The thickness of the lava varies from 300 to 900 feet, each sheet having a thickness of 30 to 45 feet; the layers are separated by rather thin intercalations of tufa. In this part of the island a bed of limestone may be observed; it is of recent formation, for it contains shells now living in the surrounding sea. The ancient lavas of Pico d'Antonio are anterior to this limestone, which contains fragments of them.

Amongst the rocks collected near Porto Praya are to be mentioned, in the first place, specimens which may be referred to limburgite. They are of a reddish grey colour, with numerous vesicles in which natrolite has crystallised. Under the microscope it is seen that this rock contains an abundant, brownish, vitreous base, and is transformed, along the veins and fissures, into a reddish substance which may be observed in rocks of the basaltic series undergoing modification into palagonite. In this base are observed pretty large and remarkably well outlined sections of olivine. This mineral is little if at all altered, and the only inclusions observed in it are crystals of magnetite. Several crystals are frequently joined with parallel axes; the sections in this case show outlines with re-entering angles; but in many cases it may be ascertained with polarised light that these crystals are not twinned, but simply juxtaposed. There are others, however, in which the phenomena of polarisation show that the axes of elasticity are oriented so as to render the existence of a twin highly probable. The two crystals are joined at an angle of about 45° or 50°, but the irregularity of the contours does not allow it to be measured with precision. If these crystals are examined with convergent light, there may be observed on one of them a bissectrix, indicating the plane of an optical axis perpendicular to the long edge. On the other may be already observed the lemniscates, and an arm of the hyperbola oriented in the same way. The observations make it sufficiently probable that the two crystals may be twinned, with a dome as composition plane.

[1] Darwin, Geological Observations on Volcanic Islands, pp. 1–22, ed. i., London, 1844.

[2] Doelter, Die Vulkane der Capverden.

[3] Doelter, *loc. cit.*, p. 44.

In the brownish vitreous mass there are numerous small microliths of augite, almost colourless, or of slightly purplish tint; these crystals are often grouped in the form of a cross or star, but it was not possible to ascertain the law of this intercrossing. The zeolites, as is generally the case with the rocks of this type, have been formed in drusy cavities, lining them with a rather thin layer, which is almost colourless or only slightly bluish between crossed nicols.

A rock with an enamelled calcareous coating, found on the coast, must also be classed with limburgite. It is black, more massive than the preceding, slightly vesicular, and has the macroscopic characters of basalt. Examined with the microscope it is seen that all the constituent elements are the same as in the rock just described; its base is, however, less developed, and all the microporphyritic crystals, especially those of augite, are of a larger size. The olivine shows its cleavages in a more distinct manner, and it is penetrated and corroded by the magma. The vitreous mass is less homogeneous, and less transparent than in the rock last described; in some places it is filled with trichites, and irregular granules of magnetite.

A rock specimen broken from a steep cliff near the slaughter-house of Porto Praya is of a greyish dark-blue colour, compact, and with an even fracture. No mineral is discernible by the naked eye. With the microscope it seems to be allied to felspathic basalt. Grains and crystals of olivine, already changed into a yellow substance on the edges, are, with magnetite, the most conspicuous elements; they are enclosed in a network of minute crystals of plagioclase and augite. Small veins, lined or filled with zeolites, traverse the rock.

In this locality other basaltic rocks were collected which must be classed with the dolerites. They are remarkable for the large dimensions attained by the crystals of augite, which often measure more than a centimetre. Under the microscope the outlines of the sections of augite are very distinct, and show that this mineral is perfectly developed on all its faces. It is often twinned according to the ordinary law $\infty \mathrm{P}\!\!\!-\infty$; at other times the crystals cross each other in such a way that the traces of the faces r : r′ form an angle of about 80°; in this case all would seem to indicate that the crystal is twinned following the dome $-\mathrm{P}\!\!\!-\infty$. Some crystals of pyroxene are zonary, and possess the hour-glass structure; some of these have an internal structure which only shows itself with polarised light. A section with irregular outlines shows striæ in connection with the zones of growth; this section is traversed by a series of parallel lines corresponding to the prismatic cleavage. It may be seen between crossed nicols that it is traversed by three series of lamellæ, of which one is almost perpendicular to the direction of the cleavage, the two others being perpendicular to one another, and making an angle of about 45° with the first. The pleochroism is—

β	>	γ	>	α
reddish.		violet.		yellowish.

Between these large crystals of augite may be seen grains of olivine often partially serpentinised, and pretty common lamellæ of biotite and magnetite; the plagioclase is partially transformed into saussurite, and almost always presents itself in the form of elongated lamellæ with large extinctions similar to those of labradorite. These felspars, which are generally small, form almost alone the ground-mass enclosing the other crystals.

A lava from the same locality is slightly scoriaceous, of a reddish grey colour, with an irregular fracture. Olivine reddened by oxide of iron may be seen with the lens. Amongst the microporphyritic minerals, which are perceived under the microscope, may be specially mentioned olivine and magnetite with subordinate felspar. These larger minerals are enclosed in a ground-mass formed of a base, devitrified by globulites, microliths of augite, and of felspar and secondary minerals, such as hematite, etc.

The large sections of olivine, perfectly crystallised, are magnificent examples of pseudomorphs of hematite. This last mineral appears opaque with transmitted light; with reflected light its dark-red colour is clearly seen. In this nearly perfect transformation of the hyalosiderite into hematite, certain parts of the primitive crystal have preserved their transparency and all their optical properties. This apparent anomaly is explained if it be remembered that this alteration of the mass of olivine does not take place in a uniform manner; the trichites or the small veins of hematite advance in directions determined by microscopical cracks; they afterwards enlarge, sometimes leaving small patches where the alteration has not yet commenced, and these preserve all their properties. By the form of these pseudomorphosed sections, it seems that it is really olivine which formerly occupied all the space invaded by the hematoid substance. When the little colourless patches of these sections are examined in polarised light, they all darken at the same time; this in its turn proves that they form the last remains of a single crystal.

The felspars show themselves in an abnormal manner. Usually, in the basalts, plagioclase presents itself with a considerable clearness of outline. Here, on the contrary, they have the appearance of an intercalated mass of which the crystallisation has been impeded by the surrounding minerals. They are grains without regular outlines, and the striæ of the plagioclase are scarcely marked; they present in places an undulating extinction, produced perhaps by alteration. If an analogy to these felspathic grains were to be sought for in other rocks, they might be compared with the plagioclases as they exist in meteorites of the type of chrondrites.

Small augites, yellow by alteration, form almost the whole of the ground-mass; they are found together with grains of magnetite, and transparent reddish brown sections extinguishing parallel to the edges. This mineral cannot be precisely determined. If the form, almost always quadratic, which it presents be taken into account, it might perhaps be classed with perowskite, but the colour is too red, it is not sufficiently

purplish. On the other hand, this mineral is found with the form of parallelogrammic sections which have in their aspect a great analogy to bronzite; the optical properties of the mineral under parallel light might agree with this opinion, although the great number of quadratic sections seems unfavourable to it. The minute size of this mineral prevents its examination in convergent light, and we therefore leave it undetermined. As stated before, the base has undergone globulitic devitrification.

One of the specimens collected near Porto Praya belongs to the phonolites. This rock is greenish grey, with waxy lustre, compact, with shining macroscopical felspathic lamellæ, which can be seen with the naked eye in the ground-mass. Under the microscope this rock shows the structure and composition of phonolite. Rather large hexagonal and quadratic sections must be ascribed to nepheline; they are colourless, crossed in the quadratic section with rectangular lines of cleavage; the hexagonal sections remain dark when rotated between crossed nicols; the quadratic, on the other hand, extinguish parallel to the sides. The polarisation colours are of a bluish shade, and rather pale. The hexagonal sections show, with convergent light, a very indistinct black cross; the double refraction is negative. The lines of cleavage are very marked, and are parallel to the base of the prism; twinning is never observed in them; but the optical phenomena show certain anomalies which must be due to mechanical action. This rock also contains large crystals of sanidine, twinned according to the Carlsbad law; they show the characteristic fractures and extinction of this mineral. These peculiarities, but specially the optical phenomena in convergent light, prevent these sanidine sections being mistaken for nepheline. These sections show the arms of the hyperbola of biaxial crystals; and, moreover, a section twinned according to the Carlsbad law sometimes shows on the left individual, for example, a bissectrix indicating that the plane of the optical axis is parallel to the composition plane, whilst the other individual presents phenomena very analogous in aspect to those of the monaxial crystals. Here, no arm of hyperbola is to be seen, but as it were a very eccentric cross, whose arms are perpendicular and parallel to the length. To observe these phenomena it is not necessary that the section should be twinned: we see, indeed, single crystals, prismatic like those in question, some of them showing the bissectrix, the others the pseudo-black cross. Rather numerous crystals of titanite and lamellæ of biotite are found in the microscopic preparations. It is difficult to ascertain the true nature of small dichroic needles, with vague outlines and slightly fibrous at both ends, which are embedded in the rather altered ground-mass. Some of these needles give straight extinctions, others extinguish at about 20°; it seems probable that they belong to augite.

We have examined some specimens of calcareous rocks found near the coast at the south of St. Iago, to which Darwin devoted a very detailed description.

Among our specimens there were fragments of the limestone taken from the raised beach he describes.[1] We refer to his book on Volcanic Islands for the details relating to the changes which have affected this calcareous rock in contact with the overlying volcanic products. Doelter[2] remarks that he was able to trace this alteration only on a layer of 10 inches, at the contact of the limestone and lava. The limestone has become granular, and some of its grains are rather large. These are the only phenomena of contact observed by Professor Doelter at San Jago. Other observations on the same subject made by Darwin must, according to Doelter, be explained in another way.

A specimen of limestone from this raised beach has been collected at the contact of the lava. This calcareous rock is massive; the layer near the lava is opal blue, and the grains are somewhat larger; the other part of the specimen is brownish. Calcareous grains and small fragments of volcanic material are cemented by infiltrated calcite. Near the zone of contact the grains are of a deeper blue, but the saccharoid structure is not clearly shown. The calcite of this thin zone of contact effervesces with hydrochloric acid, leaving a residue composed of organic matter; it yields only a trace of magnesia. The white and bluish grains are fragments of organisms, as can be ascertained by microscopic examination. Under the microscope it is seen that the organic structure is not entirely destroyed; the sections showing this are less transparent than those of infiltrated calcite, and they are speckled with brown and bordered by a yellowish zone. The secondary calcite is clear and crystalline, showing the rhombohedral cleavage characteristic of this species. The small volcanic fragments embedded in this limestone are splinters of basalt, palagonite, augite, olivine, hornblende, and biotite. They are isolated and entirely surrounded by infiltrated limestone. Microscopic concretions of iron and manganese oxide are also to be seen.

Another specimen from this raised beach is very like that we have just described, but it contains more volcanic fragments; among these are found all the rocks and minerals above mentioned. Augite is specially abundant. As in the former case, saccharoid structure cannot be observed. The details of the organic structure are not washed out, and the hemitropic striæ following—$\frac{1}{2}$ R are never seen.

We shall mention, in conclusion, a specimen of limestone which covers the lava on the coast near Porto Praya, and which ought to be considered as a stalactitic deposit. This specimen is brownish yellow, and is formed by the superposition of more or less folded and slightly adherent lamellæ. Calcite has crystallised in the cavities, and some small elongated scalenohedric crystals can be recognised. This coating contains compact black volcanic splinters two or three centimetres in length; these are glassy fragments passing to palagonite. Darwin observed these inclusions, and compared them rightly to the palagonite found by him in the Galapogos Islands. Under the microscope no

[1] Darwin, *loc. cit.*, p. 3. [2] Doelter, *loc. cit.*, pp. 45, 191.

organic remains can be detected in the specimen, all the calcite sections showing that this mineral has a stalactitic origin. The rock is almost entirely composed of sharply defined crystalline grains often giving triangular sections; by their juxtaposition they present a serrated appearance. The centre of these sections is generally of a brownish yellow colour, surrounded by a clearer zone; in form they can be derived from an acute rhombohedron or from a scalenohedron. This incrustation is thus essentially formed of very small acicular crystals of calcite closely packed against each other, the interspaces having been filled later by a calcareous deposit to which the rock owes its compact and shining appearance.

III.—ROCKS OF ST. THOMAS (WEST INDIES).

The specimens we have examined are fragments, concerning the original situation of which there is no information, some of them being rolled pebbles. It is consequently necessary, in the absence of stratigraphical details, to confine ourselves to a description of lithological and mineralogical features.

One of the rock specimens has a porphyritic structure with large crystals of hornblende (three to four millimetres in diameter), imbedded in an essentially felspathic ground-mass. Examination under the microscope shows it to be a much altered quartziferous diorite. The fine-grained ground-mass presents rather distinct crystals of hornblende and quartz, patches of little prisms and grains of epidote and titaniferous iron, and aggregations of decomposition products. Hornblende is the best developed and least altered of the minerals of the first generation. The maximum angle of extinction was found to be about 19°, and the characteristic cleavages are sharply marked. The pleochroism is shown in the following manner: for α pale yellow; for β yellowish brown; and for γ pale green; the absorption being $\beta > \gamma > \alpha$. These sections often show a zonary structure, the special colours of each layer being sometimes sharply defined. They are frequently twinned polysynthetically according to the law: plane of twinning $\infty \bar{P} \infty$ in sections parallel to $\infty \mathcal{R} \infty$, in which symmetrical extinctions of 19° are obtained on both sides of the lamellæ. Although the hornblende is relatively little altered, it is seen to be traversed by fissures which have become filled by secondary quartz, probably derived from the associated minerals. Quartz takes otherwise a very important place in the composition of this rock. The sections show, instead of the common irregular fractures of this mineral, a series of fissures which follow the cleavages of the rhombohedron. These quartz grains touch along straight lines, which gives them a strong resemblance to Carlsbad twins such as

are shown by sanidine. On the other hand, the abundance of liquid inclusions with moving bubbles, and, in certain cases, the outlines and their relation to the direction of cleavage, the smooth surface of the sections, and the optical characters, leave no doubt as to the true determination. Some sections, in fact, show the black cross and that the mineral is positive. Epidote is also well developed in the rock, this secondary product appearing in the form of grains, often grouped or scattered uniformly between the crystals of hornblende. The epidote is distinguished in this case by the brilliancy of its polarisation colours, and a very feeble pleochroism, citron-yellow or an almost colourless shade of green. This mineral is sometimes crystallised in fibro-radial bundles. Titaniferous iron is also somewhat common, and is decomposed into leucoxene. Crystals of grey titanite, probably derived from the decomposition of ilmenite, may also be detected. The last-mentioned mineral has sometimes left hexagonal hollows where leucoxene and epidote have subsequently developed. The ground-mass is chiefly formed of quartzose grains, epidote, and the remains of a few indistinct crystals of plagioclase. The microscopical structure shows that this rock is a diorite, and this conclusion is confirmed by the examination of the sections of hornblende. The completeness of these crystals as to their external form, and their freshness, clearly show, it seems to us, that this mineral is primordial, and does not take its origin from the paramorphosis of augite into hornblende, as frequently happens in altered diabases. The presence of quartz also indicates that the rock may be related to the quartziferous diorites, but in order to establish this determination one element—plagioclase felspar—seems to be wanting. Still, on taking into consideration certain other specimens of similar rocks from the same place, which show sections of plagioclase associated with quartz and epidote, it is easy to believe that, in the rock under consideration, the plagioclase has undergone alteration into epidote. It is necessary to mention the fact that for the classification of the rock as diorite there is no other ground than the mineralogical composition and structure, all stratigraphical data being wanting.

Another rock presenting considerable analogy with the preceding is finer grained, massive, greyish in colour, and breaks with a slightly conchoidal fracture. It also may be classed as a diorite. The naked eye detects in the mass very small crystals of felspar, and more rarely of hornblende. The microscope shows a ground-mass containing rather large sections of hornblende, the crystallographic and optical characters of which are like those of the same mineral in the rock just described, only it is more decomposed, and the zonary structure does not appear. On the other hand, plagioclase, of which only traces were perceptible in the former rock, is here much less altered, and it is possible to determine the species. The lamellar sections of this plagioclase gave an average extinction of about 6° on the trace of *M*. The symmetrical angles of extinction on the two sides of the polysynthetic lamellæ gave as an average 5°. Sections of

plagioclase are sometimes observed which are quadratic and show the striation of albite and pericline. In these sections, which are in the zone $P:k$, the extinction takes place almost parallel to the trace of M; hexagonal sections extinguish at an angle, the mean value of which does not exceed 6°. These measurements and the nature of the rock appear to show that the plagioclase in question is oligoclase. All the steps in the transition may be observed from rather large crystals of plagioclase to the small entangled felspathic lamellæ which form almost the entire ground-mass of the rock. These microliths are polysynthetic and extinguish at very small angles, showing that, from the point of view of the plagioclastic mixture, they are akin to the larger individuals which belong to an earlier stage of consolidation. It is perhaps not without interest to point out this analogy of the microliths of the base and the microporphyritic crystals. The microscopic preparations are sprinkled with black grains of magnetite or titaniferous iron. In addition epidote, and in particular calcite, may be mentioned as rather common secondary products. Calcite occurs in somewhat large sections traversed by polysynthetic lamellæ following—$\frac{1}{2}$ R. Finally, quartzose veinules were observed penetrated by small colourless lamellæ, which appear iridescent in polarised light, and are very probably scales of white mica. On taking account of the facts that no trace of calcite appears in the quartz veins, and no quartz in the sections of calcite, one is led to conclude that the infiltration of quartz and of calcite occurred at different stages in the series of secondary modifications to which this diorite has been subjected.

In the two rocks just described the specimens were referred to diorite, and we remarked the profound alteration which had attacked the hornblende in one case and the plagioclase in the other. The difficulties in the way of exact determinations may readily be understood when decomposition has to so great an extent veiled the true nature of the rock, and when so many of the specimens are rolled pebbles picked up on the shore. We incline to believe, however, that they belong to the ancient type, and these general remarks apply equally well to the specimens from the same locality which remain to be described.

The next to consider is a fine-grained greenish rock, dotted with felspar, and breaking with an irregular fracture. Microscopical examination shows the rock to be greatly altered. The felspar is associated with secondary minerals, epidote, calcite, and chlorite; sections which might belong to bisilicates are not detected with certainty, but everything goes to show that these were present in the rock before it was decomposed. It is remarkable that the felspar should not have been more altered, the polysynthetic lamellæ being still perfectly apparent. These crystals are somewhat large, and appear enclosed in a mass which is composed principally of minute lamellar sections of plagioclase. These microporphyritic crystals sometimes present sections in the form of an octagon with two long sides. This would indicate that the crystals have pyramidal faces in the zone $P:M$ (n) or in the zone $x:M$ (o). The sections extinguish at a

rather small angle, which leads one to believe that the plagioclase is akin to oligoclase or andesine. Some individuals are found extinguishing parallel to the lengthened sides, and showing no plagioclastic lamellæ, which would seem to indicate that they are orthoclase. It is difficult to decide this question, but the hypothesis is not without some basis, since the rock presents the association of quartz and felspar, which is known as micropegmatite. Now it is well known that no plagioclase intergrows in this manner with quartz. We lay no stress on the secondary minerals; the epidote appears as in the diorites already described, quartz of secondary formation is abundant, and also lamellæ of chlorite united and entangled with epidote. These minerals either penetrate the entire ground-mass, or have crystallised in microscopic geodes and fissures. The specimen examined is not homogeneous, and everything points to the conclusion that it is a volcanic tufa of ancient type, but decomposition has proceeded so far that no definite opinion can be arrived at on this point. The rock just noticed may be described as related to the diorite type, to which it shows special affinities in the small angle of extinction of the felspar. Another one now to be described departs altogether from this type. It is fine-grained and crystalline, with numerous small crystals of plagioclase and augite, and greenish black brilliant scales of a chloritic mineral. It contains a black mass which seems to have been enclosed; the fracture is almost plane. The augite crystals and the very high angle of extinction of the plagioclase distinguish this rock from the preceding. Plagioclase plays an important part in it, appearing in the form of large crystals or aggregations, and being twinned according to the albite and pericline laws. In the sections in which hemitropic striæ appear (those following the albite law crossing those of pericline at right angles), the symmetrical angle of extinction for the polysynthetic lamellæ may rise above 30°, which seems to indicate that this felspar is not far removed from bytownite or anorthite. Pyroxene appears in the form of rather large rounded crystals often twinned polysynthetically according to the ordinary law. Its colour is not dark, sometimes indeed a very pale yellow tint. This mineral has undergone mechanical changes which have given its sections a fragmentary appearance; they are decomposed on the surface, and calcite has crystallised along the edges. The augite contains cavities that may have been originally vitreous, but they have been modified by decomposition, which has also altered the base, probably vitreous at its origin, and transformed it in great part into secondary quartz and matter resembling chlorite. Although it is extremely difficult to give a decided opinion on the nomenclature to apply to rocks collected in isolated fragments and which have undergone great alteration, still, by taking account of the texture, the mineral association, and the special characters of the augite and plagioclase, one may venture to class the specimen under consideration with the diabases.

A greenish pebble with irregular fracture, sprinkled with large, more or less circular, patches of calcite, contains only one macroscopical mineral, greenish in colour, probably

augite or epidote. Microscopical examination shows that this rock may be considered as forming a transition between the series of diorites and of diabases. Although much altered, we can class it amongst the *Diabas Mandelstein* of the German lithologists. The ground-mass is formed almost entirely of felspar associated with numerous grains of epidote and other decomposition products, while a glimpse is sometimes caught of small vague prisms of augite. Crystals of felspar of the first generation are rather well developed; they occur as thick shortened prisms, several being sometimes grouped together. They are twinned according to the albite law. The angles of symmetrical extinction on the two sides of the hemitropic lamellæ, and of that following the trace of *M*, are generally somewhat small, seldom exceeding the average value of 7° or 8°. Augite is the best represented mineral of first generation; it appears as grains, and shows the characteristics we recognise in amphibolic rocks such as diorite. There would be no hesitation in classing this rock as a diorite, if the hornblende were better characterised, but only doubtful traces of this mineral are to be found in the form of hexagonal sections which might have been amphibolic originally, but are now only pseudomorphs. These sections are almost as large as those of felspar, the contours being sometimes clearly defined; in other cases they merge into the surrounding ground-mass. With polarised light the mineral in question behaves like an aggregate; some indistinct patches take a bluish tint or remain unaffected, and these might possibly be nepheline or apatite. Secondary quartz is developed, but not to such an extent as epidote, which appears to penetrate the whole mass; its grains, although often very small, are recognisable by a slight citron-yellow pleochroism, brilliant colours of polarisation, and an irregular surface. It is abundant in the cavities, where it has crystallised in the form of a fan, and is associated with calcite. Sometimes the nearly circular vesicles, which give the rock the appearance of a *Diabas Mandelstein*, are filled with these two minerals often associated with chlorite.

A rolled pebble, reddish brown in colour with dark green grains of augite and white grains of altered felspar, is a clastic rock. This tufa contains all the minerals mentioned in the rocks already described. The ground-mass is made up of small, more or less abundant, crystals of plagioclase, and of lapilli, which are distinctly separated from each other and cemented by a coating of ferric hydrate. The large fragments of felspar, which are seen scattered sporadically through the preparations, have the same optical and crystallographic properties as those described above. These sections are usually rounded, and are partly altered, not however by kaolinisation, but rather by zeolitisation; instead of small micaceous lamellæ with iridescent tints in polarised light, these sections are seen showing a blue colour which extends over pretty large surfaces separated by colourless intervals. Numerous crystals of zeolites are also to be seen in the vesicles of the rock. Epidote has crystallised in the interior of the felspar; with calcite and chlorite they occasionally entirely fill the

place of the primary plagioclase. The sections of augite show the fragmentary nature of the mineral even better than those of felspar by their notched and cracked outlines. This pyroxene is almost colourless, as was the case also in the other rocks from this locality which have been described. It is recognised by its vivid colours of polarisation and by its characteristic cleavage. Although epidote appears for the most part to have been formed where it is found, there are sections of it which bear unmistakeable traces of having belonged to an original crystalline rock. We have said that epidote has crystallised in the vesicles of the diabases from St. Thomas, where it assumes the form of almost colourless fibro-radial groups, more or less spherical or ellipsoidal in shape; now, in the specimen just described fragments of this amygdaloidal epidote are found. This mineral is characterised by its brilliant polarisation colours, its pale tint in ordinary light, absorption, and the citron yellow pleochroism it exhibits, as well as by a slightly rough appearance of the surface of the sections. Like the felspar, this epidote appears to show vague polarisation phenomena, resulting from the stress to which the rock was subjected. Aggregations of epidote, chlorite, and quartz, which are sometimes seen as yellowish green or almost colourless patches, may very well be derived from the decomposition of a bisilicate, all further traces of which have vanished through alteration. Besides zeolites resulting from the transformation of part of the felspathic substance, these secondary minerals are found in all the vesicles of the rock, where they appear as a coating or as small colourless crystals sometimes prismatic. Occasionally they all appear to be chabasite, twinned crystals of which are recognisable.

To summarise briefly the leading features characterising the descriptions given above, we may say that, taking account of all the transitions which have been shown, the specimens from St. Thomas represent an uninterrupted series, from amphibolic rocks with acid plagioclase (oligoclase) to augitic rocks containing a plagioclase approaching anorthite.

IV.—ROCKS OF FERNANDO NORONHA.

The group of small islands called, from the principal islet, by the name of Fernando Noronha, is situated in the Atlantic, about 3° 50′ S. lat. and 350 miles off the coast of

Peak of Fernando Noronha, sketched from the deck of H.M.S. Challenger.

South America. The soundings made by the Challenger in the neighbourhood of these islands show that they rise somewhat abruptly from the bottom of the sea.

Darwin, in his work on Volcanic Islands,[1] reports that he visited Fernando Noronha during the voyage of the "Beagle," but his stay there was of short duration. He states that these islands are of volcanic origin, but that he did not observe any crater. According to Darwin, one of the most salient features of the topography is a hill about 1000 feet high, forming an escarpment, and crowned by a summit, 400 feet high, of a phonolithic rock; this rock contains, he says, numerous crystals of felspar and some prisms of hornblende. From the highest point of this hill he was able to observe that the other islands of the group had conical summits of the same nature. He recalls the fact that at St. Helena, also, great phonolithic masses occur, rising vertically to 1000 feet; these have evidently been injected into crevices while fluid. If this hill of Fernando Noronha, he adds, owes its origin to the same cause, as seems probable on other accounts, we are forced to admit that denudation has occurred here on a great scale. Near the base of this eminence Darwin observed some beds of whitish tufa, traversed by numerous dykes, some of amygdaloidal basalt, others of trachyte. He noticed, also, some beds of fissile phonolite, in which the planes of schistosity ran N.W. and S.E. Certain parts of this rock, where the crystals are less numerous, resemble slate altered by contact with a trap dyke. The lamination of the rock, which at first had incontestably been in a state of igneous fusion, seemed to him an important subject for investigation. Darwin concludes his brief description by adding that he found on the shore numerous fragments of compact basalt; they appear to come from a columnar rock which is seen in the neighbourhood.

The craggy phonolithic mass, to which Darwin alludes, is St. Michael's Mount. Mr. Buchanan[2] remarks that at the foot of the eminence the rock is columnar, while towards the summit it assumes a massive structure. On the west side of Fernando Noronha the columns are inclined at an angle of about 30° to the horizon. Their section is almost square, but the angles are greatly rounded off, and the columns are not very thick. He adds that the rock is greenish, and that crystals of sanidine occur in it, lying with their broad faces in a plane perpendicular to the length of the columns. The slopes of St. Michael's Mount are covered with blocks of massive phonolite, often decomposed, and thus exhibiting the sanidine crystals in relief. This rock possesses the characteristic properties of the phonolites: it rings under the hammer. The specimens which we have examined are less schistose or fissile than many of the rocks of the same type, but both the naked-eye and the microscopical characters confirm the determination of Darwin and of Buchanan.

One specimen, taken from a columnar block, appears compact to the eye, is greenish grey in colour, dotted with white, has an irregular scaly fracture, and a

[1] Darwin, Geological Observations on Volcanic Islands, p. 23. See also Wyville Thomson, The Voyage of the Challenger, The Atlantic, vol. ii. p. 109, London, 1877; Moseley, Notes of a Naturalist on the Challenger, London, 1879.
[2] J. Y. Buchanan, *Proc. Roy. Soc.*, vol. xxiv. p. 613, 1876.

slightly waxy lustre. With the naked eye only some crystals of sanidine, from 2 to 3 millimetres in length on the average, can be made out among the constituent minerals; cleavage lamellæ parallel to *M* are seen gleaming. The rock yields some water on heating in the closed tube; when attacked by acids it gelatinises readily. Its specific gravity is 2·635. The specimens of massive phonolite from the summit of the mountain do not differ in any essential manner from that of which the macroscopical characters have just been given.

When examined with the microscope, this phonolite shows a microporphyritic texture; embedded in a very close-grained ground-mass, in which one notices only small, somewhat irregular microliths of augite showing fluidal structure, there are seen, as minerals of the first generation, sections of nepheline, sanidine, augite, hornblende, magnetite, titanite, and nosean. We shall now consider the characters of these minerals of first generation.

Sections of nepheline are very common; they are distinguished at a glance from the other constituent minerals by the sharpness of their contours, and by their completeness. Comparison of the form of sections, cut in various directions, show that the nepheline in this rock takes the form of crystals slightly tabular, parallel to *OP*, with the faces of the prism somewhat shortened. The commonest sections are equilateral hexagons with an angle of 120°; they are remarkably limpid, and very slightly blue or almost colourless in tint. This mineral has no inclusions except titanite; it is perfectly homogeneous. The lines of cleavage which traverse it are distinct; they have the appearance of regular blackish strokes, parallel to three alternate sides of the hexagonal sections. In parallel polarised light these sections remain constantly obscured throughout a complete rotation; in convergent light it is rather rare to be able to observe the usual black cross of monaxial crystals. This mineral also presents rectangular sections with a similar physical aspect. They show two cleavages: the more distinct of the two is indicated by streaks parallel to the traces of the prism; the other, perpendicular to the first, is less marked, and is parallel to the pinacoid *OP*. These sections always extinguish parallel to the sides. Nepheline often occurs in this phonolite in aggregates of several crystals grouped parallel to the vertical axis; these aggregates are recognised by the outlines forming reëntrant angles, and, between crossed nicols, these adherent crystals are distinguished one from another by different shades of the same tint. The tints of chromatic polarisation are feeble, and generally clear blue. An alteration is sometimes seen between crossed nicols, which has already been pointed out as occurring in nepheline; we refer to a more or less complete zeolitisation. In polarised light several sections assume a darker tint than usual, at the same time they look as if stumped; but sometimes certain patches are almost colourless, and a kind of marbling is produced by this want of homogeneity. On examining these sections

more closely, one sees that this appearance is due to the presence of tufts, filaments, and lamellæ intertwined in all directions. Their aspect and their polarisation tint recall precisely the appearance of certain zeolites. The nepheline has been but slightly subjected either to the corrosive action of the magma or to mechanical deformations. It is this that distinguishes it at a glance from the sanidine, with which, but for the twins, and the peculiarities that are to be described in the latter, it might perhaps be confounded. The relief of the contours and the phenomena of polarisation, so far as colour is concerned, give us little help in differentiating these two minerals at first sight. But they can be distinguished by the irregular breaks of the sanidine, the elongation of its sections, and by its Carlsbad twins.

The sanidine occurs, as we have just indicated, in lamellæ elongated parallel to the edge P/M; indeed it can be observed that certain sections, in which the Carlsbad twinning does not appear, and which are therefore almost parallel to M, have elongated rhomboidal forms, in which are seen the outlines of the faces of the prism and of P or x. This mineral is almost always cracked by more or less irregular fissures, which seem in sections parallel to P to be perpendicular to the greatest length, while in those taken parallel to M they are sensibly parallel to the vertical axis. The action of the magma has often been exerted along these fissures, which are filled by the ground-mass; this action is also shown by the corrosion of the outlines of the mineral, so much so that no rectilinear outlines are now to be found; they are scooped out more or less deeply, serrated and sometimes rounded off. Besides these corrosions there are other phenomena in the sanidine that are to be attributed to the fluidity of the magma: the sections appear dislocated and twisted; the various fragments of a crystal are scattered and overlap one another, and it is rare to see a section of sanidine in which one cannot make out displacements and ruptures. In parallel light sections showing the composition plane of the Carlsbad twin distinctly exhibit straight extinction, which occurs parallel to their greatest length. In convergent light sections cut perpendicularly to the prismatic zone show in each of the two individuals one of the two axes situated along the length of the section at opposite sides of the plane of vision. This seems to indicate that in this sanidine the optical axes are in the plane of symmetry.

Augite is one of the most widely distributed minerals in this rock. It occurs firstly in large individuals, then microporphyritically, and lastly as immense numbers of microliths in the ground-mass. We have here to describe the large augites of first generation. The character which at once distinguishes them is their green tint; these sections are very dichroic. The forms usual in this augite are octahedral sections, with the sides that represent the traces of the prisms more developed than those corresponding to the traces of the pinacoids. The prismatic cleavage is not well marked,—on the contrary, lines of cleavage more distinct than these are to be seen running parallel to the pinacoid $\infty \breve{P} \infty$. Sections of the vertical zone are

furrowed by rather indistinct cleavages parallel to the axis c, and by fractures more or less nearly parallel to the pinacoid OP. It is somewhat rare to find the outlines well shown in these various sections: they are usually bordered by a rim of small augite prisms, which belong to the second phase of consolidation. In the sections more or less parallel to the clinopinacoid, extinctions are observed that exceed 20° and sometimes amount to 30°. The pleochroism and absorption are—

α >	β >	γ
yellowish brown.	greenish yellow.	green.

In exceptional cases it is found that the green tint of this augite changes to the reddish coloration so common in the pyroxene of basalt. The inclusions seen in these augite sections are microscopic prisms of apatite, and a few granules of magnetite.

The hornblende of this phonolite ought to be regarded as an accessory mineral; it occurs only in some few individual crystals, these being for the greater part transformed into magnetite. It has the shape of very deformed hexagonal sections, at the centre of which are brown patches markedly dichroic in brownish shades, the differences, however, arising generally from differences of absorption. These sections are bordered by a broad zone of magnetite, which tends to encroach upon the centre of the crystal, where nothing but a round nucleus usually remains. The black opaque girdle which surrounds it is homogeneous, and is not formed of an aggregation of isolated grains as is often the case,—in the amphibolic andesites, for example. This zone of magnetite is frequently larger than the amphibolic centre; in some instances the hornblende is entirely displaced, the contours of the section being the only indications of the pseudomorphosis. We always find around these sections of hornblende bordered by magnetite a second zone made up of small augite microliths crowded one over another, indeed, such a girdle of small green augite crystals is almost always found round all the microporphyritic crystals of this rock.

Of the accessory minerals titanite is that which next to hornblende is best represented in this phonolite. Its sections are in general smaller than those of the latter mineral, descending even to the dimensions of the microliths in the ground-mass. This mineral has crystallised most perfectly, and has best preserved the entirety of its forms. Sections with rhombic outlines are the commonest,—they can be set down as sections of the zone Px, for the extinctions are parallel to the diagonals, and the angular values correspond to those of the prism (129°-133°). One might conclude from the abundance of these sections that titanite has crystallised in this rock in the tabular form, and that the dominant face is more or less nearly perpendicular to the zone of the prisms. Besides these sections we find some of the same mineral that are more elongated, and, finally, others that have reëntrant angles and appear twinned in polarised light. The surface of the sections is fretted; they show a very pronounced

relief; their dicroscopism is slightly marked,—the rhombic sections just mentioned exhibiting variations of tint from slightly greyish to brownish yellow. The colours of polarisation, without being conspicuously vivid, present a peculiar appearance which may be termed irisation.

Nosean is also one of the microporphyritic elements; its sections are square-shaped, hexagonal, or octagonal; the reëntrant angles indicate multiple groupings. The individuals of this mineral are not homogeneous, the interior of the sections being riddled with inclusions often disposed in a network. The peripheral zone is not so dark in tint as the nucleus, being often greyish, or inclining to clear blue, or coloured by hydrated ferric oxide. Polarised light fails to reveal the striæ characteristic of certain noseans,—the sections are perfectly isotropic.

Besides magnetite found round the crystals of hornblende, as mentioned above, that mineral occurs also in grains, as an element of the first generation, as inclusions in certain constituent minerals,—in augite, for instance.

The ground-mass is characterised by fluidal structure. The constituent minerals are, hornblende excepted, precisely those that have already been recognised in the form of microporphyritic individuals. This ground-mass consists almost entirely of small lamellar felspars, which extinguish very often in directions parallel to the long edges, and exhibit, in most cases, the Carlsbad twinning. These small crystals of sanidine are associated and often combined with some sections of the same tint and appearance, which sections, however, are broader, better defined, and are never twinned; the outlines of these sections and their optical properties enable us to recognise them as nepheline.

The most conspicuous mineral in the ground-mass is a microlithic pyroxene; it has a green tint analogous to that of the large crystals of the same species that occur in this rock. In general the outlines of these small augites are indistinct; they are rather of the shape of elongated grains than prismatic, and where they are found to have a prismatic appearance, the outlines are indented. They are twinned according to the usual law of augitic pyroxene; they are pleochroic like the microporphyritic augites, and in some instances one can make out in vertical sections extinctions that exceed 30°. It seems very probable that titanite is represented in the ground-mass by some very small crystals. It remains to refer to one more mineral, namely, apatite. It always occurs in very small individuals, the sections being frequently parallel to the vertical axis; they show traces of the pyramid, and not merely the pinacoid as is usually the case. They extinguish parallel to the line of their length; sometimes a slight dichroism is noticed, the rays vibrating parallel to the vertical axis being bluish, those which vibrate in a plane perpendicular to the greatest length almost colourless.

Mr. Buchanan collected in the fissures which in two places scored St. Michael's Mount from summit to base, a substance having the appearance and hardness of quartz.

This mineral is concretionary, and is sometimes foliated into thin plates; it is whitish, yellowish, or yellowish brown. It scratches glass readily, and does not effervesce when treated with acids. Slices, 2 to 3 millimetres thick, are translucent. When heated in the lamp, it becomes white without melting, and the residue after this operation crumbles between the fingers. In the closed tube it yields water with an alkaline reaction, and gives off an empyreumatic smell. Qualitative analysis shows in it phosphate of aluminium and of iron, silica, and sulphate of lime.[1] Analysis gives the following composition:—

Silica, SiO_2,	0·27
Sulphuric acid, SO_3,	1·40
Phosphoric acid, P_2O_5,	50·72
Alumina, Al_2O_3,	37·03
Ferric Oxide, Fe_2O_3,	5·42
Lime, CaO,	0·98
Loss on ignition,	4·54
	100·36

The explorers of the Challenger landed afterwards at Rat Island, the most important islet of the group after Fernando Noronha. Mr. Buchanan observed on the west of Rat Island a massive basaltic rock, which we shall describe, and on the east a granular calcareous rock. "It is probable," he adds, "that this calcareous grit overlies the basalt; its structure seems to indicate that it has been laid down as drift. This consolidated sand is calcareous, and contains a large number of shells. On our way to Rat Island, in passing alongside of Booby Island, we saw that it also is almost entirely formed of this calcareous grit. No old igneous rock is to be seen in it; and seeing, from the ripple marks, that the stratification may continue under the sea-level, there is some reason to think that Booby Island is subsiding, or that it has subsided at some previous time." We shall shortly return to the calcareous grit just mentioned, but will first describe the basalt of Rat Island.

Examined macroscopically this rock is black, massive, perfectly homogeneous, and has a sub-conchoidal fracture. In the very fine-grained ground-mass some yellow granules of olivine are visible, and some very small prisms, which ought to be identified as nepheline. When reduced to powder, this rock gelatinises markedly with acids. Its specific gravity is 2·957. Microscopical examination places it among the nepheline basalts. At first sight, what strikes one is the absence of polysynthetic felspathic lamellæ. The very fine-grained ground-mass is seen under high powers to be composed essentially of nepheline and augite, without interposition of vitreous matter. These two minerals have in general vague outlines, still there can be distinguished some colourless hexagonal sections that remain dark during a complete rotation between

[1] J. Y. Buchanan, *loc. cit.*, pp. 613, 614.

crossed nicols, and some rectangular sections, slightly elongated parallelograms, that extinguish in directions parallel to the sides. It is not difficult in this case to recognise nepheline, though in other cases it is disguised in the mass under the form of rounded grains, but these are connected by a complete series of transitions with the distinct sections just described. The granular shape prevents this mineral from being confounded with felspar, which never has this appearance except where, as in granitoidal rocks, it is associated with quartz. With these microliths and grains of nepheline are associated small prisms of augite, slightly yellowish or brownish and with vague outlines, some of which have large extinctions. Owing to the difference of refractive index between nepheline and augite, the latter is sharply separated from its neighbouring mineral. An interesting feature of this rock is the presence of large olivine crystals, almost always fragmentary; it is the only microporphyritic mineral present, and is much larger than the two species just mentioned. The sections of olivine are rugose, almost colourless; they are bounded by the traces of the dome and of the prismatic faces; they extinguish parallel to the line of their length. Often they suggest by their shape a well-developed crystal of olivine; at other times we see that they are only fragments of a single individual, which can be readily restored with the help of the corresponding pieces to be found in neighbouring sections. It is apparent that these olivine crystals, belonging to the very first phase of consolidation, have been subjected to dislocation and to the corrosive action of the magma. They are broken at the edges, and sometimes the ground-mass has penetrated the interior of the crystal. All the olivine sections are altered to yellow on the sides; when the sections are small this zone of hydrated ferric oxide is so much developed that nothing may remain but a small colourless area at the centre of the section. A tendency to assume a fibrous structure is noticeable in the sections of this mineral. Several sections of olivine are often seen grouped and joined together; in polarised light these clusters sometimes exhibit phenomena that vividly recall those observed in twins, but here the planes of junction are too vaguely indicated to allow a positive statement; nevertheless there are such sections showing two individuals laid together and having a shape perfectly reconcilable with that of well-known twins of the rhombic system. Amongst the accessory minerals we must note black mica, occurring in irregular scales strongly pleochroic, and giving straight extinction; this mica is often intimately associated with the decomposed olivine; it sometimes even occurs as an inclusion in that mineral, which contains also some particles of secondary calcite. This carbonate is present also in very fine filaments in the ground-mass; it is recognised by its irisation, by the twins parallel to $-\frac{1}{2} R$, and by its cleavage. Worthy of interest is the presence of very numerous minute grains of perowskite distributed throughout the ground-mass, where they play a part almost as important as that of magnetite. Perowskite is hardly ever found in well crystallised individuals, though sometimes traces of octohedra can be made out.

Usually it takes the form of grains with rugose surface, sometimes broken, transparent, with a blue tint inclining a little to violet, and with very decided relief; in general these sections are isotropic. Magnetic iron in the shape of grains or of microscopic crystals is tolerably abundant, and is distributed throughout the mass. Lastly, there are still to be noted some small prisms of apatite.

The limestone mentioned above, which was collected by Mr. Buchanan in the south-east of Rat Island, shows on a freshly-fractured surface a compact rosy or yellowish mass, with small white crystalline specks and yellow or blackish grains less than a millimetre in diameter. The white specks are shells, the yellow and black grains are fragments of rocks and of volcanic minerals. This rock is moderately hard; it often presents on its surface a scoriaceous aspect, and sometimes also cavities are seen in the interior. When treated with hydrochloric acid it leaves a residue of about 30 per cent. of its mass. Under the microscope this rock resolves itself into crystallised colourless limestone, devoid of any trace of organic structure, and forming, one may say, the paste or cement of the clastic grains of organic or mineral origin. These grains of calcite are of two sizes: some are very large, while others, smaller and probably of secondary formation, occupy the intervals left between their larger neighbours. Carbonate of lime also occurs, in microscopic acicular crystals. The mineral and organic particles are all clastic and worn, each being surrounded by a narrow zone of calcite. Among the minerals olivine is frequently visible, coloured red by decomposition; other grains consist of small splinters of basaltic rock,—among them being some particles of basaltic glass changed into palagonitic matter. A rock almost identical with this limestone of Rat Island was found by Mr. Buchanan overlying the basalt of Platform Island, of which we are about to speak.

The islet of this group that goes by the name of Platform Island is composed of columnar basalt, on which lies an extensive and uniform bed of calcareous rock, the specimens of which are, as we have said, analogous to the limestone of Rat Island. The basalt of Platform Island is slightly more granular than the nepheline basalt described above. It is black, and slightly vesicular, while to the naked eye only some crystals of augite are visible, embedded in the ground-mass. Under the microscope this rock proves to be felspathic basalt. In a ground-mass, in which from their number certain small felspathic lamellæ predominate, we find large microporphyritic crystals of augite, and sections of olivine of smaller size; the plagioclase as well as the magnetite are always microlithic. The augite sections are not very prismatic; the crystals are more shortened than those usually observed in basaltic rocks. Sections parallel to $\infty \grave{P} \infty$ are often unsymmetrical hexagons, whose outlines represent the traces of faces of the zone *n* and *t*, and of those of the prisms. Octagonal sections also

occur, unsymmetrical like the former; these are perpendicular to the plane of symmetry, and extinguish parallel to the line of their length. The extinctions measured on the face $\infty P \infty$ exceed 40°. Sections more or less perpendicular to the axis c are fairly regular octagons, in which the traces of the pinacoids are more developed than those of the prisms. The augite is filled with vitreous inclusions, which are accumulated at the centre of the crystals; round this non-homogeneous nucleus is a zone of slightly reddish tint, the nucleus being usually not so dark. The optical phenomena are disturbed by an incipient alteration, which shows itself in the formation of chloritic material. The prismatic cleavages are not distinct; they are, rather, irregular cracks; the cause of this anomaly lies in the presence of so great a quantity of vitreous inclusions. Besides the twin following the ordinary law, some sections of augite seem to be twinned with a composition plane parallel to a face of a pyramid, as has already been observed in augite. The vitreous inclusions are irregularly shaped; their colour is generally faint, but sometimes they assume the colour of the augite which contains them. One is led to suppose that there might have been a partial refusion of the pyroxenic element, but what renders this interpretation hypothetical is that the external zone which surrounds these nuclei, and which is entirely homogeneous, has not been altered at all. This fact appears to dispel all idea of a later caustic action exerting itself on the crystal. Besides the vitreous inclusions, some are to be seen consisting of grains of magnetite or of greenish patches of secondary origin, and probably of a chloritic matter.

The olivine shows under the microscope some interesting peculiarities in regard to its decomposition. This mineral occurs in grains or in sections of the ordinary form, and with the trace of the pinacoid $0P$, hence some sections have octagonal forms. When the olivine is not altered it is colourless, its surface rugose, its chromatic polarisation vivid; still, it is somewhat rare to see this mineral undecomposed. Sections are often observed having the outlines of olivine, but showing that this mineral is invaded by alteration products. At first the olivine is changed into a yellow pleochroic substance possessing the characters of biotite. It shows a lamellar cleavage, along the traces of which absorption is more marked. The colour is brownish yellow along this direction, yellowish in the line perpendicular to these lamellæ. They extinguish following the direction of the joined lamellæ. The sections parallel to the lamellæ remain dark during a complete rotation between crossed nicols; with convergent light these latter sections exhibit a black cross. The double refraction is negative. All these characters completely justify the determination as biotite. In certain cases the olivine presents a less advanced decomposition. The yellowish matter which tends to encroach upon it bears less distinctly the characters of black mica; it is not lamellar, and it is difficult, even when it is possible, to detect any absorption; perhaps this is mica in the course of formation. In some cases one sees around the biotite certain more or less capillary accumulations, presenting sometimes a vaguely radial arrangement, and probably

arising in their turn from the decomposition of the biotite. Without insisting too strongly on this point, these accumulations, to judge from their form, bear a resemblance to those of hornblende called *pilite* by Dr. Becke, a product which he has pointed out as the result of the decomposition of olivine in certain kersantites of the Waldviertel. In some cases the product of decomposition of the olivine is a greenish substance, the absorption of which is less marked than that of the biotite; it is more finely fibrous than the latter mineral, and the fibres are more interlaced and less continuous than are the lamellæ of black mica; we regard this green substance as serpentine. Amongst the inclusions of the olivine, we must mention magnetite and some chestnut-brown grains belonging probably, judging from their transparency, to a spinel.

The ground-mass contains a large number of augite sections which are generally more prismatic than the microporphyritic crystals of this species. The plagioclases, which occur only in the ground-mass and as microliths, yield very elongated sections with polysynthetic striæ. The extinctions observed in the sections of the zone $P:M$ are moderately large, and they are included between the angles 5° and 26°; it is therefore likely enough that this mineral is allied to labradorite. Among the microlithic crystals of the ground-mass one notices very small patches of a vitreous colourless substance. Sometimes this base is coloured slightly yellow, but this tint is secondary, arising from the decomposition of the ferruginous minerals that constitute the rock. To this same decomposition is to be attributed small nests of greenish chlorite which line certain cavities wherein this mineral has crystallised in interwoven lamellæ. We may remark, in conclusion, that this basalt approaches the doleritic type in its texture.

V.—ROCKS OF ASCENSION.

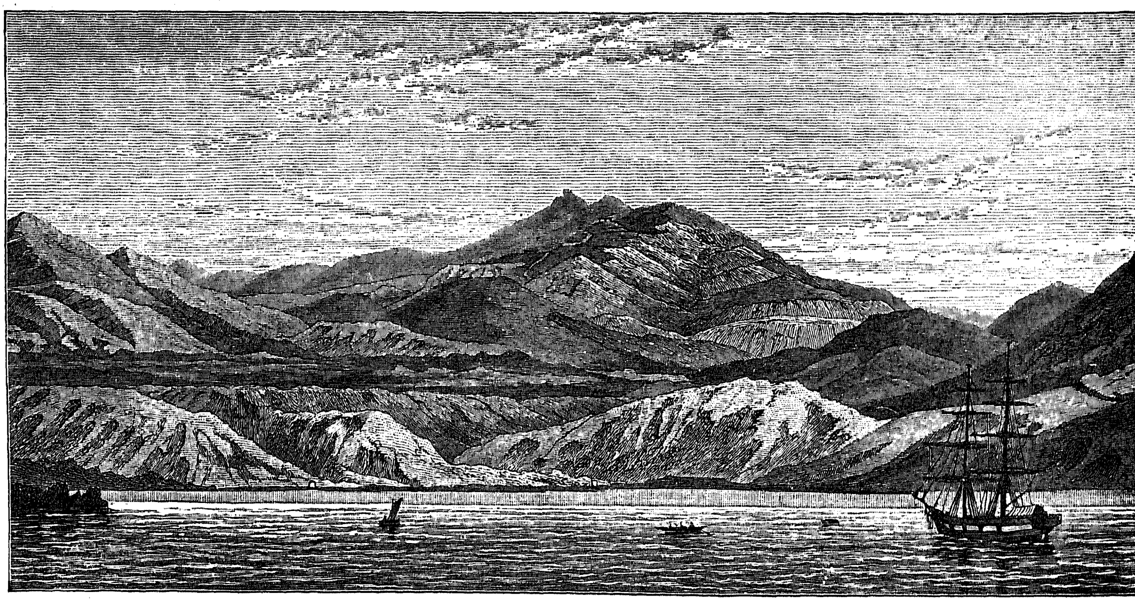
Darwin in his book on Volcanic Islands has given a very detailed description of the rocks of Ascension;[1] but during the time (almost half a century) which has elapsed since the appearance of that work, no one has, to our knowledge, published any special paper on the petrography of this island.[2] We are now able, in some measure, to fill this gap, thanks to the materials collected during the stay of the Challenger, and by Dr. Maclean, R.N., one of the Challenger officers, who lived for some time on the island. Dr. Maclean has placed at our disposal specimens of the principal rocks that he collected, and also some local information, of which we have availed ourselves in the following notice. We have arranged our material very much in the order adopted in Darwin's Geological Observations, and have recapitulated a good many of his local details. It

[1] Darwin, *loc. cit.*, pp. 34–72.

[2] Murdoch has analysed the well-known obsidian of Ascension (*Phil. Mag.*, 1844, p. 495). Vom Rath described the crystals of hematite of this island, associated with magnoferrite (*Zeitschr. d. deutsch. geol. Gesellsch.*, Bd. xxv. p. 108, 1873). Ehrenberg has shown the nature of certain siliceous deposits of the "crater of an old volcano" (see p. 68 of this Report).

is worth while noting that, although he wrote at a time when our knowledge of crystalline rocks was in its infancy, the main features of his system remain unaltered. It is right to add that Darwin had been preceded at Ascension by Lesson, who had already given pretty precise indications of the nature of the rocks of this island.

The Island of Ascension is situated in the South Atlantic Ocean, in latitude 8° S., and longitude 14° W.; according to observations made by the officers of the Challenger, the central summit is in latitude 7° 56′ 58″ S., and longitude 14° 20′ W. The form of the island is an irregular triangle, each side measuring about 6 miles; it is $7\frac{1}{2}$ miles long and 6 miles wide. The surface is very irregular, and on a general view appears sterile and miserable in the extreme, presenting an expanse of black, burnt rocks, unrelieved by the least vestige of soil. The highest point of Green Mountain, situated



The Green Mountain and Extinct Craters, Ascension Island.

in the east of the island, rises to 2870 feet above the sea, and from the summit one sees forty or more little peaks scattered about in all directions. The accompanying woodcut will give some idea of the appearance of the island, which is entirely volcanic,[1] and in

[1] Lesson, in his description of Ascension, states his belief that the island is formed of a single volcano, the dejecta from which built up Green Mountain. "All the other eminences which rise to the north and on the plateau of the island without regular order, either as isolated cones or in groups, are more recent volcanic openings, the craters of which, symmetrically formed as a rule, are directed towards the principal volcano, Green Hill, on the side of the prevailing wind, producing a steep declivity in this direction. These fire-breathing mouths are very regularly characterised in the secondary mountains of Ascension, but less so in those of Cross Hill, Red Hill, Zebra Hill, etc.; the greater number present craters in a state of perfect completeness. Green Hill derives its name from the verdure of a vigorous growth of plants upon its summit. The vegetation ceases at the lower third of the mountain, which is composed of naked rock piled up confusedly according to the fractures it has undergone. All the other mountains are quite bare, covered with ferruginous scoriæ of a prevailing red colour. The surface of the island is composed of a detritus of trap and trachyte pulverised and deposited here and there in beds of small extent, bordered everywhere

the absence of proofs to the contrary Darwin considered it as of subærial origin. Like most volcanic islands in the course of prevailing winds, Ascension has steep precipices on the exposed side, where landing is very dangerous ; the west coast is less abrupt, and there the British Residence is established. The influence of the prevailing winds appears not only on the exposed coasts, but cinders and lapilli have been carried from the centre of action in a westerly direction, and these have even been blown into the sea, where the accumulation of incoherent volcanic products forms a bottom which affords good anchorage. No traces are anywhere to be found of the island being at present in a state of volcanic activity, but the cones of tufa are so little altered, their contours are so sharp, and their brown and red colours so fresh, that they produce an irresistible impression that the island has been quite recently formed by an accumulation of cinders and scoriæ, and that the fire still smoulders under the crust. The fundamental rock is everywhere of a pale grey colour, and belongs to the trachytic series. These masses of trachyte are best seen in the south-east part of the island. Almost the entire surface is covered by streams of black scoriaceous lava of a basaltic nature. These beds are dominated in certain places by hills, or isolated trachytic rocks. From the Challenger's anchorage no trace of vegetation was visible except the light greenish tint near the summit of Green Mountain, 6 miles from the coast; all else was lava, black and grey cinders, and volcanic peaks and cones. We might refer for geographical details to Campbell's map,[1] in Darwin's Geological Observations, but it does not present an exact and complete view of the island. It is now advantageously superseded by that of C. A. Bedford, of H.M.S. "Raven," published by the Hydrographic Office in 1838, a copy of which accompanies this Report (Map II.). Bedford's map shows the limits of the scoriaceous rocks sufficiently clearly ; they stretch along almost the whole coast-line on the north and south, dipping towards the sea, and are cut through by the channels of the streams. The layers of scoriaceous lava are less apparent on the east and west ; they only appear here and there, or form a belt along the shore. To the north of the island these beds crop out again to a great extent, and send out branches which surround the isolated hills of East Crater, Sister's Peak (1459 feet), and Bear's Back. In the central and most disturbed part of the island lava is less common ; it is, properly speaking, the region of trachytic rocks. In this central region, a little to the east, the

with heaps of the fragments of black lava called 'clappers' by the English. . . . The shore is also composed of black, trachytic, and porous lava, the surface being vesicular. . . . High sharp rocks shoot up from the sand. Elsewhere, at the west point of Sandy Bay, the rocks are of black basalt, or covered with a thin greyish-white layer of obsidian like a varnish." Lesson also notes calcareous deposits on the coast. We have cited this passage from the naturalist of the "Coquille," because it is, we believe, the first work in which the geology of the island is sketched. These few lines give the gist of his description. We shall return farther on to some of the details he pointed out. We may refer for the history of Ascension, and an account of its fauna and flora, to Sir Wyville Thomson's work, The Atlantic, vol. ii. p. 262, etc.; to Moseley's Notes of a Naturalist on the Challenger, p. 561; and to the Narrative of the Cruise of H.M.S. Challenger, vol. i. p. 927.

[1] A Plan of the Island of Ascension, by Lieut. Robert Campbell, 1819; frontispiece of Darwin's Geological Observations.

most important mass in the island occurs, Green Mountain, of which we have already spoken. It includes, besides the peak to which allusion has just been made, several pretty high summits. Weather Post Hill (1965 feet) is situated towards the east, and a little farther south there is a large depression in the form of an elongated ellipse which bears the name of Cricket Valley. Booby Hill[1] (1790 feet), to the south of the valley which borders the central heights of Green Mountain, is also associated with that mass. In the same central region, but more to the west, is Riding School Crater, and still farther west Red Hill. Cross Hill is situated near the village of Georgetown. We have now enumerated and stated the position of the principal hills which will be referred to in this Report.

Augitic Trachytes.

We have said that trachytic rock forms the fundamental mass of the island, and we shall commence the description of the rocks by that of the trachytic type, giving first, according to Darwin,[2] the macroscopic characters. They occupy the highest and most central part of the island, and also occur in the south-east region. This trachyte is usually of a pale brown colour, speckled with black spots; it contains folded and broken crystals of glassy felspar, grains of hematite, and black microscopic particles which Darwin referred, doubtfully, to hornblende. The greater number of the eminences are formed of a white friable rock.[3] Obsidian, hornstone, and several other zonary felspathic rocks are associated with the trachyte. The last-named is never stratified, nor are crater-formed orifices ever found on the eminences. The trachytic region must have been violently dislocated; the fissures are still open, or partially filled with loose fragments. The space occupied by these trachyte masses is bounded by a line which surrounds Green Mountain and joins the hills of "Weather Post Signal" and "Crater of an old volcano." Trachyte predominates in the region thus circumscribed; it is traversed by some veins of basalt, and near the summit of Green Mountain there is a stratum of vesicular basalt enclosing crystals of glassy felspar with rounded outlines.

The soft white rock mentioned above bears a close resemblance to a sedimentary tufa when seen in the mass. Darwin hesitated for some time, as many other geologists have done in analogous cases, before he rejected this theory of its origin. He observed, on two separate occasions, that the white earthy rock formed isolated hills; in another

[1] Dr. Maclean points out in a manuscript correction of Bedford's chart, of which we avail ourselves, that the name "Booby Hill" should be substituted for "Red Hill." The latter name should be given, as I say in the text, to the hill west of Riding School Crater. The rocks described in this Report as coming from Red Hill were collected by Dr. Maclean, and were obtained from the hill situated in the position which he has marked on the map.

[2] Darwin, Geological Observations, pp. 42–44. In summarising passages we have preserved as much as possible the mineralogical and petrographical nomenclature, and the interpretation of facts given by the author. One might, in some cases, be able to modify them, but this would involve the risk of making more or less arbitrary changes, since we have not the specimens Darwin employed to refer to.

[3] It may be that in certain cases the rock spoken of by Darwin as whitish trachytic tufa is siliceous earth, as in the case of the whitish deposits of Riding School Crater.

place it was associated with a columnar and zonary trachyte, but he could not make out the contact. The white rock which he studied contained numerous crystals of vitreous felspar, and black microscopic points. It is speckled, like the surrounding trachyte, with dark grains. On examining the ground-mass with a lens, Darwin found it to be earthy; sometimes, however, it possesses a crystalline structure. On the eminence called "the crater of an old volcano," it passes into a greyish green variety, which only differs in colour and by being more compact. Here an insensible transition between the two rocks is observable. Another variety is made up of numerous round and angular fragments of the greenish rock embedded in the white matrix. Both these varieties of trachyte are traversed by irregular veins which do not at all resemble intruded dykes, and Darwin states that he never saw the like elsewhere. Both kinds of trachyte contain isolated fragments, varying in size, of a dark scoriaceous rock, the vesicles of which are filled by the white mass. This trachyte also includes large blocks of dark cellular porphyry, containing many crystals of opaque white felspar and altered crystals of oxide of iron. The cavities are encrusted with capillary crystals. These fragments project from the decomposed rock in which they are embedded, and exactly resemble the nodules of sedimentary rocks. But, adds Darwin, we know many cases of pieces of cellular rock being shut up in trachytes and phonolites, and therefore cannot draw as a conclusion from the facts described that these rocks were of sedimentary origin. The insensible passage of the greenish into the whitish variety in some cases, and the isolated nodules in others, may result from a greater or less difference in composition. The rounded form of the blocks may be due to corrosion by the fused mass in which they were stuck. He considers the veins to be due to the infiltration of silica. The principal reason Darwin brings forward for believing that these earthy and friable rocks are not sedimentary is, that it is extremely unlikely that crystals of felspar and grains of mineral should occur to precisely the same extent in a sedimentary mass as in a trachyte with which the former was associated. Besides, he observed that the rock matrix showed a crystalline structure when magnified.

After giving these details from Darwin of the appearance and occurrence of the trachytes of Ascension, we shall describe the specimens of this type which we have studied.

As Darwin's account shows, trachytic rocks play a considerable part in the island. It would not be easy to devote a special description to the specimens of each locality, especially since very often—not to say always—we have no information as to the definite part of the bed from which the rocks were taken, the label only bearing the name of the hill. We may add that all the rocks of this kind, from whatever part of the island they come, are very like each other.

We shall accordingly describe them together, grouping the rocks according to their lithological affinities, but, in the case of those meriting special attention, mentioning the locality from which the specimen came.

The rocks under consideration may be described under the general name of *Augitic trachytes*, and are characterised by the association of three constituents in greater or less amount: monoclinic felspar, augite, and a vitreous ground-mass. Their mineralogical composition is very constant, and the characters well defined,—the slight variations being due to differences of texture, and to the more or less important part played by the vitreous matrix. All stages of transition are to be found between holocrystalline varieties showing an aggregate of augitic and felspathic microliths, with some microporphyritic crystals of sanidine, and vitreous varieties, in which there occur a few extremely minute crystals of sanidine and augite. Finally, the vitreous element becomes supreme, and the rock passes into obsidian.

The trachytes properly so called are whitish grey in colour, sometimes bluish grey, with a rough granular structure. The ground-mass is homogeneous, rarely slightly schistoid. Sometimes they are slightly vesicular, and pass into pumice; or are more compact, and, according to the predominance of the vitreous element, darker in colour and with a somewhat glossy sheen. The fracture is usually irregular. In some cases the trachytes are friable, in others they are rough to the touch and coherent. Some specimens which have commenced to alter, and are marked with round brownish stains, are impregnated with oxide of iron, which gives them a red or brown colour. These trachytes, when examined with the lens, are found generally to be composed of crystalline grains, but the species could not be made out, except in the case of sanidine, crystals of which are sometimes visible to the naked eye.

Microscopic examination shows that all the trachytes of Ascension have an almost identical microtexture. They possess a ground-mass chiefly composed of confused microliths of sanidine and augite, to which large sections of felspar give a microporphyritic structure; the sections of augite are less numerous. Sometimes a base is interposed between the microliths of the ground-mass; the latter is seldom devitrified in spherulites or trichites. A peculiarity of the minerals in the ground-mass is that they are always comparatively small; this minuteness, and the confused setting of the microliths, makes their determination difficult. The sanidine appears in large crystals with the distinguishing peculiarities of this species. These large individuals are always corroded, their outlines are blunted, they are furrowed by lines of fracture which sometimes correspond to traces of cleavages ∞P, and almost always twinned according to the

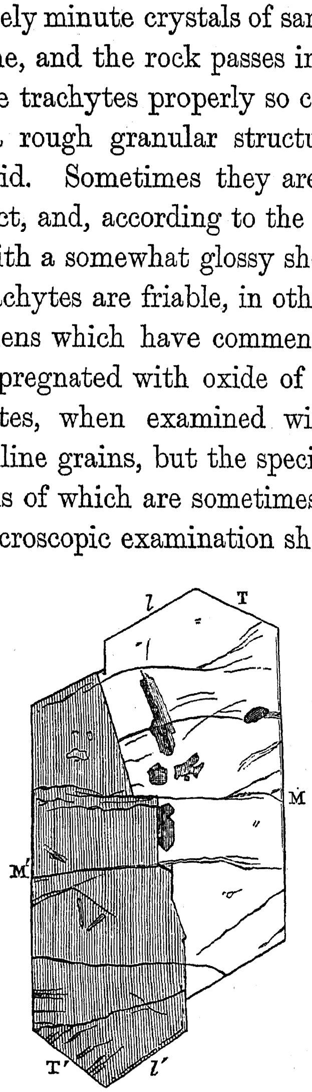


FIG. 6.—Trachyte of Weather Post Hill. Section of sanidine cut almost parallel to *P*/*M*, Carlsbad twin. The composition plane is *M*, and another face probably $\infty \breve{P} 3$. $\frac{1}{20}$ crossed nicols.

Carlsbad law. We may point out, in speaking of these twins, that the plane of union may vary in one and the same crystal. Fig. 6 shows a section of the mineral twinned according to this law. It is cut almost parallel to the edge P/M; and it may be observed that the plane of composition is now M, traces of which appear on the two long sides of the section; and again another plane, which may correspond to a prism, perhaps to $\infty \breve{P} 3$, a face known to occur in sanidine. These large sections have frequently an undulated extinction. The felspathic microliths of the ground-mass are referable to the same species. The striæ of plagioclase are never observed. One form predominates—it is that of extremely thin lamellæ, which, when seen on the face M, appear almost always twinned. Two of the individuals are regularly superimposed, but one does not entirely cover the other. Fig. 7 gives an example of one of these twinned crystals: it shows two tabular individuals of sanidine superimposed on the face M, and twinned according to the Carlsbad law; traces of P and y are discernible, and the internal zones give an indication of x. Extinction takes place with an angle of $+ 5°$, the angle $P\ P'$ is 127°; it is thus equal to that which the same faces of sanidine twinned according to the Carlsbad law form. The aspect of this twin may vary to infinity, but the fundamental form is so constant that it is certain to occur in each preparation; it is produced even when the crystals become infinitesimal, as in the case of the very vitreous varieties of this rock (see fig. 8).

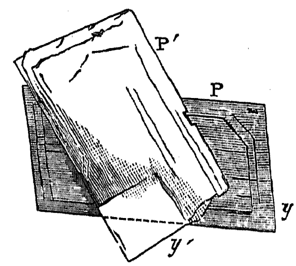


FIG. 7.—Trachyte of Red Hill. Small twinned crystals of sanidine, two tabular individuals superimposed on the face M, the traces of $P\ y$, and, in the internal zones, the trace of x can be seen; the angle $P\ P'$ is about 127°. $\frac{1}{60}$ crossed nicols.

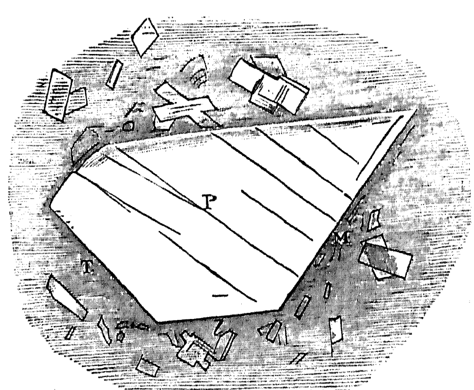


FIG. 8.—Trachyte of Red Hill. Large section of sanidine in a vitreous ground-mass is surrounded by small lamellar crystals superimposed and twinned, embedded in the base. The cracks traversing the large section are almost perpendicular to M. $\frac{1}{40}$ crossed nicols.

Plagioclases, sharply distinguished by hemitropic striation, occur very rarely. Felspathic sections may sometimes be observed showing some appearance of polysynthetic lamellæ, which are, however, indistinct compared with those of plagioclastic felspars. The

sections showing these striæ have almost always undulated extinction, and are grooved by fissures; they are sometimes broken in several pieces and cemented together by the matrix. These facts clearly show that the felspars exhibiting those striæ have been subjected to mechanical strain, which has induced a more or less pronounced lamellated structure, and this, under the microscope, has an appearance resembling that of a plagioclase. These sections, then, are nothing else than sanidine modified by mechanical action. But there is another kind of alteration in this felspar to which attention must be drawn. We have said above that the large sections of sanidine almost always appear corroded at the edges. This action of the magma is not confined to the border of the crystal, but in some cases has affected the whole mass, softening it and transforming it almost beyond recognition. The facts, as they were observed in a great number of specimens of trachyte from Ascension, were as follows:—Certain sections, which were naturally supposed to be ground-mass, so crammed were they with microliths of irregular outline, extinguished polarised light as if they formed one crystalline individual. What seems to go against this interpretation is, that these sections are filled with the same felspathic microliths composing the ground-mass. On examining them more closely, however, one can find all stages of transition represented, from the perfect crystal of sanidine downwards, and the conclusion must be that they are nothing else than large crystals of sanidine attacked by the action of the magma. In fact, some of these patches, with half-effaced contours, are surrounded by little crystals of sanidine forming an external zone, and encroaching on the primitive crystal, sometimes to the centre. The magma, in which these crystals of sanidine floated, may be admitted to have penetrated them in some way, and to have given rise to the microliths. The influence of the fused mass had not been sufficient to make the crystals lose their individuality completely; their outlines were effaced, and they were invaded by microliths, but they did not mix entirely with the magma, and hence did not lose their molecular structure.

Augite is the second essential element of these trachytes. We have said that it never attains the dimensions of the sanidine; it always occurs in the prismatic, almost acicular, form, and is confined in the ground-mass with the little lamellæ of sanidine. In most cases augite is associated with a vitreous base. The small crystals are greenish, slightly dichroic; the octagonal form of sections perpendicular to the vertical axis is rarely seen; the angle of extinction is often greater than 45°. The microliths of augite are sometimes reduced to mere lines, especially in those specimens where the vitreous matter predominates. These fine needles are nearly always altered, as can be seen from the yellow tint they assume, the colour changing from green to yellow or brownish red. In some rather rare cases they become fibrous, as if they had been subjected to uralitisation. Sometimes microliths belonging to a second generation are observed; the comparatively large crystals are surrounded by an outer zone of

minute green needles of the same nature. In very vitreous varieties it is not uncommon to see the microliths grouping themselves in a manner resembling the arborescent forms which certain pitchstones exhibit.

Accidental constituents play a very small part in the rocks we have just described. Magnetite occurs pretty frequently, titanite and apatite more rarely, and sometimes sections of quartz; but these are probably of secondary origin, as are also the grains and veins of hematite and limonite.

We give below an analysis by Dr. Klement of one of the trachytic rocks; the specimen came from Weather Post Hill, and its characters correspond with those described above.

I. 1·0401 grammes of the substance, dried at 110°C and fused with carbonates of soda and potash, gave 0·7384 gramme of silica, 0·1543 gramme of alumina, 0·0430 gramme of ferric oxide, 0·0062 gramme of lime, 0·041 gramme of magnesium pyrophosphate, and traces of manganese.

II. 0·8480 gramme of substance treated with hydrofluoric acid gave 0·1871 gramme of sodium and potassium chlorides, and 0·1048 gramme of potassium chloroplatinate.

III. 1·0950 grammes of substance treated in a sealed tube with hydrofluoric and sulphuric acids was titrated by potassium permanganate. 0·7 cubic centimetre of solution (1 c.c. = 0·005405 gramme of ferrous oxide) was required to oxidise the ferrous oxide.

IV. 1·0370 grammes of substance fused with sodium-potassium carbonate, according to the method of Sipöcz, gave 0·0041 gramme of water.

PERCENTAGE COMPOSITION OF THE SPECIMEN.

Silica, SiO_2,	70·99
Alumina, Al_2O_3,	14·84
Ferric Oxide, Fe_2O_3,	3·76
Ferrous Oxide, FeO,	0·35
Manganese,	traces
Lime, CaO,	0·60
Magnesia, MgO,	0·14
Soda, Na_2O,	5·94
Potash, K_2O,	2·40
Water, H_2O,	0·40
	99·42

The percentage of silica given by this analysis is too high for normal trachyte; in fact in unaltered specimens it only amounts to 65 per cent., which corresponds to the amount of silica in sanidine. In exceptional cases certain trachytes may contain as

much as 71 per cent. of silica (the tridymite trachyte of New Zealand, for example), but this large proportion is due in great part to the infiltration of siliceous matter subsequent to the consolidation of the rock. To infiltration of this kind we have recourse in order to explain the anomaly in the present case. We have already said that the trachytes of Ascension contain little veins of quartz of secondary origin, and the ground-mass is sometimes penetrated by silica. Darwin remarked the frequency with which siliceous veins occur in the whole region, and infiltration of silica of secondary origin accounts for the divergence in the analysis before us. The small proportion of ferrous oxide, magnesia, and lime clearly shows that pyroxene is a very subordinate constituent of the rock. We see besides, as analyses of trachytes often show, that soda predominates over potash in a marked degree. Perhaps we have here a monoclinic felspar which would approach those described by Förstner (2·1 mol. $Na^2\ Al^2\ Si^6\ O^{16}$, with 1 mol. $K^2\ Al^6\ Si^6\ O^{16}$). Vom Rath showed that in the sanidines of Laacher-See soda may be present in larger amount than potash; perhaps small plagioclases are hidden in the ground-mass, which may itself contain a glass more or less rich in soda.

We have considered the pyroxenic trachytes, and now turn to the specimens which show a transition to obsidian.

The ever-increasing predominance of base over crystalline elements is shown very well in a specimen from Red Hill (?). The external appearance is still quite that of ordinary trachyte; to the naked eye it shows a rather pronounced schistoid appearance. The colour is grey, darker than the ordinary trachytes of the island; it is still slightly rugose, and has not assumed a vitreous texture. Crystals of sanidine from 3 to 4 millimetres long determine a porphyritic structure in the rock. When a thin section is examined, the large share which the vitreous mass has in its constitution becomes apparent. The schistose appearance is also found in the preparation,—it is produced by lines of vesicles, which, like those of pumice, are due to the liberation of gases during cooling. Well-developed felspar and augite microliths are ranged in the same direction as the vesicles. It is without doubt to its fluidal structure that the lamination of this rock must be attributed. Large sections of sanidine and augite, but mostly the former, detach themselves from the vitreous ground-mass, which is light brown in colour with slightly darker bands. The sanidine is sometimes found crystallised as a Carlsbad twin. Plagioclase is occasionally detected. Besides the minerals already mentioned, the ground-mass is filled with little bundles of crystals extremely minute and only appearing under the highest powers. Relying on microscopic analyses only, these obsidians could not be separated from the augitic trachytes. In fact, one sees that the latter rock is related through all its transitions with the former, and that the constituent minerals are the same in both; only the vitreous element tends gradually to take the place of the minerals, which grow smaller as the trachyte approaches the vitreous

variety. Obsidian is simply the last term of this series, and its external characters are then sharply defined. We shall describe here some of the more or less vitreous varieties of trachyte, but as the texture and the mineralogical composition are always fundamentally the same, it is unnecessary to follow all the stages of transition. We shall accordingly say a few words about the highly vitreous trachytic rocks, and afterwards enlarge upon the well-characterised obsidian of Ascension.

Vitreous augitic trachyte sometimes appears as a greyish mass, soft and very friable, somewhat scoriaceous and passing into pumice, but more homogeneous in the fracture. Its macroscopic characters are like those of a tufa, but microscopically the ground-mass is seen to contain no heterogeneous fragments, being composed of microliths and a vitreous mass. In this matrix microporphyritic crystals of sanidine appear; the crystals of augite are always smaller than those of the felspar with which they are associated.

Obsidian.

All the obsidians of Ascension are closely related to the trachytic rocks which have just been described. Before discussing the mineralogical characters of these volcanic glasses, it will be well to give a *resumé* of Darwin's very detailed observations[1] upon them. He first describes the transition of the rocks into zonary[2] beds between which the obsidian is intercalated. These outcrops of the beds of obsidian in the middle of the trachytic region west of Green Mountain are highly inclined, and partially covered by more recent eruptions; for this reason Darwin could not observe their contact with the trachyte, nor satisfy himself as to whether they had been poured out like lava, or injected like the veins in the adjacent rocks. At the point explored by the author three beds of obsidian appeared, the largest at the base of the section. These alternating rocks attracted the particular attention of Darwin, and he described five varieties which passed into each other by all gradations. We refer the reader for particulars regarding these varieties to the complete description given in the chapter of Darwin's book dealing with the subject.

The transition of these zonary rocks to beds of true obsidian takes place in several ways. At first angulo-nodular masses of obsidian of varying size appear isolated in a schistoid or massive felspathic rock of a light colour and conchoidal fracture. Then irregular nodules of obsidian are seen, isolated, or grouped in layers not more than the tenth of an inch thick, which alternate repeatedly with thin strata of a zonary felspathic

[1] Darwin, Geol. Observ., pp. 54-62.

[2] We employ "zonary" instead of Darwin's term "laminated" in this description. He explains his meaning of the latter word in a note at the foot of p. 54 *loc. cit.*: "This term might be misunderstood; it is applied to rocks which divide into thin leaves of the same composition, or are formed of closely united layers of different mineral species without a tendency to split up, but distinguished by special colours. The term laminated is employed here in the latter sense. When a homogeneous rock has a cleavage plane along which it may be readily split, like slate, I apply the term *fissile*."

rock resembling agate, and sometimes passing into pitchstone. A white substance resembling pumiceous cinders fills the interstices between the nodules of obsidian. Finally, the substance, which previously was spread through the rock, becomes an angulo-concretionary mass of obsidian of a pale grey colour, and often traversed by coloured bands parallel to those of the enclosing rock. Darwin then describes the rocks which usually occur as stages in the transition to obsidian, and treats in a specially detailed manner of the linear arrangement of spherulites. He explains the nodular form of some specimens of obsidian by viewing them as concretionary masses like spherulites. After discussing the chemical composition of these obsidian spherules, as known at that time, he attributes the nodular and spherulitic forms to a process of segregation in the fused mass which led to the separation of the parts richest in silica. He pointed out the similarity between the phenomena exhibited by volcanic glasses and the devitrification of artificial glass. Finally, Darwin compares his observations on the obsidian of Ascension with those of Beudant in Hungary, of Von Humboldt in Mexico and Peru, and with the descriptions by other geologists who had brought analogous facts to light in various volcanic regions.

Having recalled Darwin's work on the obsidians of Ascension, we shall proceed to give a lithological description of the specimens of this rock which we have examined; these came from Green Mountain. When the specimens are not weathered, they present all the ordinary characters of obsidian, being black, vitreous, with a brilliant lustre, conchoidal fracture, and transparent at the edges. They are often cracked, the margins of the fissures appearing as white lines, and sometimes they are slightly scoriaceous with a more irregular fracture. When weathered the surface becomes greyish and earthy in appearance, and when the rocks decompose they sometimes assume a waxy lustre like retinite. They are often veined with greenish or greyish lines, and at other times finely zonary; in this case they are seen by the naked eye to be furrowed with little undulating parallel veins that stand out grey against the black background of the rock. When zonary obsidian weathers, its conchoidal fracture is obscured, and the fragments break along the zones. The only macroscopic constituent is sanidine, which stands out from the ground-mass in vitreous grains, sometimes of considerable size. Microscopic examination shows that all the obsidians of Ascension are made up of a light brown vitreous matter, the colour of which becomes darker in bands where microliths accumulate. Microporphyritic structure is somewhat rare, and when seen it is always brought about by sections of sanidine. The glass is, however, never homogeneous; besides the elongated vesicles, often arranged in bands, there are little lamellæ of sanidine and minute prisms of augite[1] scattered through the base.

[1] Darwin points out (p. 55 *loc. cit.*) that Miller determined as augite some fine green needles in the rocks of Ascension associated with obsidian. The rocks yielding these microliths also contain, according to Miller, crystals of quartz, which he measured and found possessed of the faces P, z, m, without a trace of r.

These crystals are often infinitesimal, appearing as mere lines, which it would be impossible to identify were it not that they merge by insensible gradations into well-characterised crystals of these species. It is only by following the gradually diminishing size of these minerals, step by step, from the augitic trachytes, in which they are easily recognised, to the obsidians, that they can be determined in the latter rocks.

Sanidine is, as we have said, the only constituent attaining any size. Sections of this felspar cut parallel to the face *M*, and showing the traces of *P*, *y*, *T*, give positive extinction. Carlsbad twins are sometimes seen, but never hemitropic striæ; the latter observation holds good of the large crystals as well as of the numerous microscopic sections of felspar in the ground-mass. These very minute colourless microliths are probably also sanidine; the mode of their development, their form, and their twinning relate them to the larger crystals of these species. Only the faces *P*, *y* are usually to be seen; but in certain cases *x* is also represented. Like the larger specimens of sanidine, these are tabular, extremely thin, and elongated following *P*/*M*. They are often twinned according to the Carlsbad law, as we have already described in the case of trachytic rocks. Two of these thin lamellæ are often superimposed with oblique axes, and this mode of composition recurs so persistently that there is no doubt of its being a twin, although the extreme minuteness of the crystals makes it impossible to ascertain the law. The felspathic crystals grow smaller as the vitreous ground-mass becomes more developed, but they are always distinguishable from augite, being colourless, and generally rather larger than those of pyroxene. The augite crystals never attain the proportions of those of sanidine; they are always prismatic, but with ill-defined margins; the colour is greenish, and the angle of extinction rises from 35° to 40°. This is also the angle of extinction of the little microliths, but when these assume the form of capillary lines, their optical properties cannot be observed, and their identity is only arrived at by considering the transitional forms.

The obsidians are sometimes devitrified, and exhibit a finely granular texture; some of the vitreous rocks of the obsidian series show perlitic structure, and have the shining appearance of pitchstone.

The following is an analysis of a specimen from Green Mountain, which presented all the appearances of an unaltered volcanic glass. An early analysis by Murdoch[1] is given for comparison.

I. 1·0752 grammes of substance dried at 110°, and fused with sodium-potassium carbonate, gave 0·7818 gramme of silica, 0·1376 of alumina, 0·0461 of ferric oxide, 0·0062 of lime, 0·0029 of magnesium pyrophosphate and traces of manganese.

II. 0·7699 gramme of substance treated with hydrofluoric acid gave 0·1415 gramme of sodium and potassium chlorides, and 0·1538 of potassium chloroplatinate.

[1] Murdoch, *Phil. Mag.*, 1844, p. 495.

III. 1·5307 grammes of substance, treated in a sealed tube with hydrofluoric and sulphuric acids, was titrated by a solution of potassium permanganate (1 c.c. = 0·005405 gramme ferrous oxide), of which 4·2 c.c. were required for oxidation.

IV. 1·2723 grammes of substance fused, by Sipöcz' method, with sodium-potassium carbonate, gave 0·0061 gramme of water.

PERCENTAGE COMPOSITION OF THE SPECIMEN.

	Klement.	Murdoch.
Silica, SiO_2,	72·71	70·97
Alumina, Al_2O_3,	12·80	6·77
Ferric Oxide, Fe_2O_3,	2·64	6·24
Ferrous Oxide, FeO,	1·48	...
Manganese,	traces	...
Lime, CaO,	0·58	2·84
Magnesia, MgO,	0·10	1·77
Soda, Na_2O,	6·50	11·41
Potash, K_2O,	3·87	
Water, H_2O,	0·48	...
	101·16	100·00

TRANSITIONS OF AUGITIC TRACHYTE INTO AMPHIBOLIC TRACHYTE, ANDESITE, AND RHYOLITE.

The Green Mountain contains a great many rocks transitional between augitic trachyte and neighbouring lithological types.

We shall first consider amphibolic trachyte. This is a compact greenish grey rock, in which crystals of sanidine may be discerned by the naked eye; the surface is partly covered with brilliant crystals of hornblende, to which reference will be made later. The microscope reveals hornblende also amongst the essential constituents, which are otherwise similar to those of augitic trachyte. The sections of hornblende show decided pleochroism, the absorption being almost as intense as for biotite; they are characterised by the cleavage, but the planes of separation are not sharp; on account of a slight deviation in their direction, they appear as curved lines. Titanite may be noticed in the form of inclusions in the amphibole. It seems very probable that free silica in the form of quartz is a constituent of the ground-mass; but, perhaps, this mineral is a secondary product, as is very frequently the case in the rocks of Ascension, a great number of which are silicified.

This rock shows a very interesting peculiarity which has been already observed, particularly by Vom Rath, on some blocks ejected from Vesuvius. The whitened and softened appearance of the specimen indicates that it has been subjected to the action

of fumaroles. The altered surfaces are sown with extremely brilliant little black crystals, standing out in relief, and never forming a part of the ground-mass on which they are set. They are found in every hollow, but never on a freshly broken surface. These crystals are never more than 1 or 2 millimetres long; several individuals are often united with the axes parallel; often also they are hollow or present a skeleton-like appearance. Microscopic examination shows that the dominant faces are ∞P, which are usually relatively well developed; indications of $\infty \breve{P} \infty$, $\infty \bar{P} \infty$, P, $0P$ are also seen. The angle of the prism *mm* measures 124° 30′. With the microscope a well-marked cleavage following the faces of the prism may be made out, and when the crystals are broken the very elongated prismatic solids of cleavage present the same angle of 124°; these little prisms have a maximum angle of extinction of about 15°. Although only slightly transparent, the crystals show a perceptible pleochroism; the light ray vibrating parallel to c is of a more or less deep green, that perpendicular to this direction being reddish green. These details prove beyond doubt that the crystals are hornblende, and that they must have been formed by sublimation like their congeners of Vesuvius, which, as described by Vom Rath,[1] are in every way similar. No true amphibolic trachyte has been found amongst the specimens from Ascension. The rock just described is only a transitional type, and the same may be said for the next specimen to be considered. This rock, from a quarry near Georgetown, is an augitic trachyte passing into amphibolic andesite. To the naked eye it hardly differs from the common trachyte of the island; it has the same greyish colour, but is perhaps a little more scoriaceous, as indicated by a certain roughness to the touch. The microscope shows a ground-mass composed of microliths of felspar and minute corroded crystals of hornblende, showing the characteristic cleavage, brownish green in colour and dichroic. Small augites, extinguishing under a high angle, and with the usual appearance of this mineral in the trachytes of the island, also occur, and magnetite is a somewhat frequent constituent. Sanidine in large sections is the principal mineral constituent; the crystals, which have an undulating extinction and are corroded, occur in groups and twins as described in the case of augitic trachytes. Finally, there are some finely striated fragments of plagioclase, occasionally twinned according to the Carlsbad or Baveno law. The presence of plagioclase indicates a transition from the series of trachytes to that of andesites.

Pyroxenic trachyte passes in some cases into rocks in which the siliceous element is isolated, and this forms a transition to rhyolite.

A specimen from Red Hill (?) is an example of this transition. It is bluish grey, spotted with black, and contains lamellæ of sanidine 3 or 4 millimetres long amongst a compact crystalline ground-mass. This mineral appears arranged in parallel lines; indeed, only the large shining face of a cleavage plane, parallel to *M*, is to be seen there.

[1] Mineralogische Mittheilungen (*Pogg. Ann.*, Ergänzungsband vi., p. 198, 1874.)

Thin slices show a magma impregnated with quartz (perhaps of secondary origin), and containing sections of felspar, augite, quartz, and biotite. The felspars are both sanidine and plagioclase; these two felspars are to be seen in the same section, as is often the case in transitional rocks such as that under consideration. The centre is, in these cases, finely striated like an oligoclase or andesine, and surrounded by a zone in which plagioclastic lamellæ no longer appear. These lamellæ in the nucleus extinguish at a very low angle, which confirms the determination as a triclinic felspar approaching the oligoclase series. The felspathic microliths of the ground-mass are often Carlsbad twins, and frequently appear almost rectangular in section. This leads to the conclusion that their prevailing form is determined by the lengthening of the edge P/M. The crystals of augite present only indistinct or irregular outlines; this mineral is little, if at all, pleochroic. The biotite is in the form of corroded lamellæ, which sometimes take a greenish tint, indicating an incipient alteration into chlorite. Some colourless sections show the properties of quartz, giving the cross of monaxial crystals in convergent light. This mineral is, very probably, also represented in the ground-mass of the rock. It is noteworthy that all the older constituents, especially the felspars, have been very much corroded, as if they had been subjected to the energetic solvent action of an acid magma.

More distinctly rhyolitic rocks occur in Ascension, especially in the interior of the crater-like orifice of Riding School. A specimen of this type is compact—in some places a little scoriaceous—with a nearly plane fracture, and of a brick-red colour. The naked eye can only detect some crystals of felspar. The microscope shows that the red colour is due to an amorphous powder of hematite, which has penetrated all the fissures and vesicles of the rock. The colourless ground-mass is spherulitic and impregnated with quartz; large sections of sanidine appear in it. This mineral is crystallised in a tabular form, sometimes in shortened prisms, and the Carlsbad twin is common. A section in the zone $P:M$, in which cleavages corresponding to P and to the prism with traces of T or l are clearly shown, has made it possible to measure the angle of extinction on M. It was found to be positive and 10°, which confirms the determination of the felspar as sanidine. Some colourless homogeneous sections with irregular outlines must be referred to quartz, as in convergent light they show the cross of monaxial crystals and the usual properties of thin slices of that mineral. The presence of quartz as a microporphyritic constituent leads us to refer to the same species certain much smaller sections, which present the same appearance and the usual optical properties of this mineral in parallel polarised light. These little sections are, as it were, drowned in the ground-mass; they are associated with numerous sharply defined felspathic microliths. The ground-mass is thus essentially quartzose, and is characterised besides by the presence of spherulites, which resemble pseudo-spherulites, the cross being vaguely indicated, and its arms not at right angles. Probably this is a fibro-radial

mixture of small microliths of felspar and quartz, such as is often observed in certain porphyries and rhyolites. The pseudo-spherulites have a black opaque centre, composed of a reddish or greenish non-transparent material, which assumes a more or less starlike form, and underlines the fibres of colourless minerals forming the radiated aggregate. The dark substance of the spherulites may be related to certain rather rare small pleochroic sections which possess some of the properties of hornblende or of biotite. Perhaps hornblende, now decomposed, formed at one time an integral part of the rock.

Rhyolitic tufas also occur in the island, but amongst the specimens of rocks from Ascension which we have examined, only one belongs to this type. To the naked eye it exhibits a number of bluish grey, zonary, slightly schistoid splinters, embedded in a pretty homogeneous mass. Under the microscope the rock appears like a breccia of volcanic fragments cemented by chalcedony, or, in some cases, by hyaline quartz. The fragments are angular and irregular in form, as if crushed; they are essentially vitreous, and contain felspathic microliths, which are so minute that the species cannot be established except in rare cases when microlithic plagioclases are observable. The spherulitic structure, to be seen in certain cases, also confirms the reference of these fragments to rhyolite. In the centre of the spherulites, or following the radii, there is a black opaque substance like magnetite, trichitic rods of which may be seen scattered through the whole ground-mass, and giving it a blackish tint. Like a great many of the rocks of Ascension, this tufa contains scales of hematite. The cement uniting the fragments is siliceous; in polarised light one sees that the quartz forms a brilliant mass of grains bordering and planted on the sides of the lapilli. These grains fill up the gaps, and when the space is not quite filled up by them, it forms a geode, in which crystals of quartz, with faces of the prism and pyramid, may be distinguished.

Finally, we shall consider a tufaceous rock from Dry Water-Course. This tufa is shown by the microscope to be composed of fragments of different kinds of rock, all belonging, however, to types which are represented at Ascension. These splinters, or lapilli, have been embedded in a more acid vitreous mass, showing fluidal structure and of a yellowish colour, which, penetrating the interstices between the fragments, corroded them. The large crystals of sanidine are rounded at the edges; the augite seems to have been entirely fused. Spherulites are visible in the vitreous substance; the silica has been subsequently infiltrated. There is enough quartz in the ground-mass to justify the name of rhyolitic tufa which we apply to this rock, but there is also silica of secondary origin, which has penetrated the crystals of felspar; they appear in polarised light as a mosaic of quartzose grains.

Basaltic Rocks.

We have said that almost the entire surface of Ascension is covered by streams of black, scoriaceous, basaltic lava, through which the trachytic escarpments crop out. According to Darwin,[1] this lava is sometimes vesicular and at other times massive. It is black in colour, and sometimes contains many crystals of felspar, olivine predominating in rare cases. The streams appear to have been not very fluid; the lateral walls are extremely steep, and attain a height of 20 or 30 feet. The surface is very scoriaceous, and from a little distance it appears covered with small craters. These mounds are heaps of scoriaceous lava of the same kind as that forming the mass of the stream; their form is more or less regularly conical, and they are traversed by fissures, which give them a columnar appearance. These hillocks rise to 10 or 20 feet above the stream, and Darwin attributes their formation to the accumulation of viscous lava at points where some obstacle presented itself to the flow. At the base of these conical heaps, and at other points on the stream, blocks of lava are to be seen, resembling arches in appearance. Fantastic masses of scoriæ rise up over the whole surface, occasionally, according to Darwin, presenting such an extraordinary appearance as hardly to be distinguished from trunks of trees. Some of these lava-flows may be traced to their point of origin at the base of the great trachytic mass, or to the isolated conical hills of reddish rock situated in the north and west of the island. Darwin counted twenty or thirty of these cones of eruption from the central eminence. Most of them have their summits truncated obliquely, the steepest slope being on the south-east side facing the prevailing wind, as Lesson[2] points out. Hennah remarks, in addition,[3] that in Ascension the most extensive beds of ashes are always found in the lee of the wind.

This arrangement of the volcanic hillocks may be explained by taking account of the fact, that during eruptions the incoherent products would be carried in the direction to which the prevailing winds blew.

The basalts collected by the Challenger Expedition at Ascension are almost always of the felspathic variety; dolerites rarely occur.

Amongst the rocks of the type of ordinary basalt we may describe the specimens from Red Hill. They are completely penetrated with oxide of iron, and present a porphyritic structure by reason of crystals and grains of plagioclase—attaining a maximum diameter of a centimetre—embedded in a slightly vesicular ground-mass. Olivine is very rarely seen, and augite more rarely still. Microscopically the rock is formed of a ground-mass in which plagioclase microliths predominate, almost always twinned according to the Carlsbad law, and associated with little crystals of augite. Larger sections of magnetite, augite,

[1] Darwin, Geol. Obs., p. 34. [2] Lesson, Voyage de la "Coquille," p. 490.
[3] Hennah, *Proc. Geol. Soc. Lond.*, vol. ii., p. 189, 1835; cited by Darwin, *loc. cit.*, p. 35.

olivine, and triclinic felspar appear in this mass. The triclinic felspars are prismatic, relatively very thick, and zonary. The zones are not numerous, as in the case of andesine, for example, but usually consist only of a nucleus and an outer coating. Extinctions of about 37° have been measured on sections parallel to k, which indicate a plagioclastic mixture approaching bytownite. The cut (fig. 9) shows a section of one of these felspars perpendicular to the edge P/M. The traces of two cleavages parallel to P and M are visible, and on the right there are the remains of a twinned individual following the albite law, and almost entirely removed by the process of polishing. The two individuals extinguish symmetrically at 40°, which again establishes the very basic nature of this plagioclase. This section is instructive in exhibiting clearly the form of the large felspars in the rock under consideration. The felspar is often corroded or broken, and the fragments scattered at a little distance from one another, separated by the ground-mass. It is also apparent that certain sections have been subjected to pressure; they present traces of undulating extinction, which is particularly the case in the plagioclase represented in the figure, where this extinction is indicated by the shade in the middle towards the right margin. In other specimens of basalt the plagioclases have quite a simple structure—as in the case just spoken of: they show the Carlsbad twin and one or two hemitropic lamellæ interposed, the somewhat small angles of extinction making them approach labradorite.

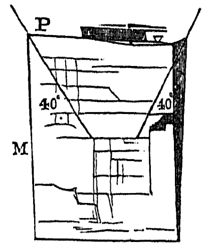


FIG. 9.—Basalt of Red Hill. Section of plagioclase perpendicular to the edge P/M, with the traces of two cleavages parallel P and M; on the right, remains a part of an individual twinned following the albite law. $\frac{1}{20}$ crossed nicols.

Olivine appears in sharply defined sections. The decomposition of this mineral is somewhat remarkable, as it changes into hematite with the simultaneous development of trichites. Such an altered crystal with the curved and parallel lines of the trichites invading the mineral is shown in fig. 10. Sometimes the little olivines of the ground-mass have a quite pronounced prismatic form, which makes it difficult to distinguish them from microlithic augite. The augitic microliths are colourless like olivine, but the sections of the latter are edged with a zone of limonite which serves to distinguish the species. There is little to say about the large crystals of augite, which appear less often in these specimens than is usual in basalts, the commonest form in this case being microlithic.

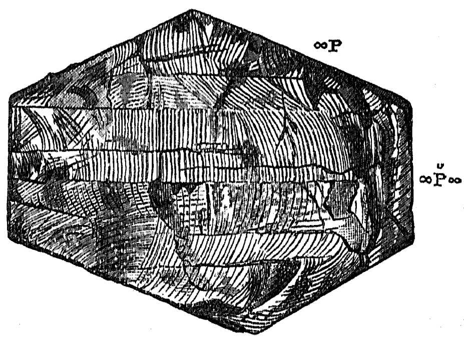


FIG. 10.—Basalt of Red Hill. Section of olivine decomposed into hematite and filled with trichites. $\frac{1}{10}$ crossed nicols.

These rocks have often a vesicular appearance when in thin slices, although they seem perfectly massive when looked at with a lens. The vacuoles are generally due to

the disappearance of sections of peridotite, which crumble and are swept away during the polishing. The basalts of the island are often scoriaceous; a basaltic lava from Riding School which we have examined is particularly so: it is a reddish scoriæ, very alveolar and rough, and containing heterogeneous half-fused fragments.

The microscope shows a ground-mass of a very fine grain and pitted with pores. Olivine and plagioclase appear in microporphyritic sections; the former predominates and is often fragmentary, although when the crystals are very small they are sharply defined. Augite is found in the form of microliths in the ground-mass, which contains very little vitreous matter. Little granules of hematite occur throughout the mass, penetrating all the felspathic sections where they appear in zones.

Finally, there are basaltic rocks of the dolerite type. These are greyish, almost saccharoid in texture, with pretty large grains; plagioclase crystals are visible to the naked eye, and the lens shows grains of augite between them. With the microscope it is seen that these basalts do not possess what can, properly speaking, be termed a ground-mass. The lamellæ of plagioclase felspar are twinned according to the Carlsbad and albite laws; they are comparatively little striated, and thus resemble the felspars of those basalts we have just described. The extinctions show that the plagioclase approaches labradorite. The augite intercalated in the felspar lamellæ occurs as greenish violet grains associated with magnetite, the sections of which, generally irregular, are surrounded with hematite. The olivine has corroded outlines, and is coloured red or green by alteration. The greenish secondary matter is sometimes more or less fibrous; it is dichroic, and to a certain point resembles hornblende. This transformation into amphibole would explain the oblique extinction which has been observed in olivine sections that have undergone the same alteration.

Andesites.

Certain rocks, much resembling basalts, which may be classed as andesites, are met with in various parts of the island, particularly on Red Mountain.

Some specimens of andesite from Red Mountain are bluish black or iron-grey in colour, pretty compact, breaking with a plane fracture, and resembling basalt externally. No constituent minerals can be detected by the naked eye. Other specimens of andesite are more earthy; they have a reddish colour, are impregnated with oxide of iron, and surrounded by a rather thick crust of sublimed specular iron, which is often covered with beautiful little crystals of the same mineral.[1]

Microscopic examination shows that this rock must be classed with the pyroxenic

[1] The Island of Ascension is a well-known locality for fine crystals of hematite, which probably come from Red Hill. Vom Rath found octahedral crystals of magnoferrite on a specimen of Ascension hematite. This association indicates a formation by fumaroles (see Vom Rath, *Zeitschr. d. deutsch. geol. Gesellsch.*, Bd. xxv. p. 108, 1873).

andesites; but the pyroxenic mineral is bronzite. Plagioclastic microliths and little reddish crystals of bronzite make up the ground-mass, and a good number of rather large crystals of felspar also appear in it. At first sight these seem to be sanidine, as they have the glassy appearance and the lines of fracture which one is accustomed to consider as characteristic of this felspar; but the homogeneity disappears with polarised light, and the crystals are seen to be striated like plagioclase by the intercalation of a very large number of polysynthetic lamellæ. Sometimes this felspar is crystallised simultaneously according to the albite and Carlsbad laws. In certain cases some individuals show a zonary structure. These extremely close striæ recall similar observations in sections of oligoclase and andesine, and this resemblance is confirmed by the fact that the extinction in the felspar of this rock takes place at a very low angle.

The mineral identified as bronzite is always altered, and the decomposition shows itself by the deep red tint which clothes the sections. Sometimes crystals cut perpendicular to the prism, show an octagonal form like that of augite sections. This form is, however, equally characteristic of bronzite, to which the optical properties in parallel light plainly refer the crystals, but their small size and the alteration of the mineral makes an examination by convergent light impracticable. These prismatic sections always extinguish following the length, and never show pleochroism. The alteration of this mineral not only changed the colour, but in some sections part of the substance has been eliminated, and greenish matter deposited in the hollows. The red colour produced by alteration makes these little prisms resemble certain olivines, but the outlines of the sections and the elongated form of the prism do not confirm this supposition. This bronzite is rarely found in sufficiently large crystals to induce microporphyritic structure, but occasionally some are of such a size, and in this case they are often deeply indented. A very pronounced fluidal structure appears round the larger crystals of bronzite. The mineral may be traced from the large sections, on which its determination is based, to extremely small microliths in the ground-mass. It is by analogy also that the minute crystals of plagioclase in the ground-mass are related to the larger individuals of the same species, the microliths being sometimes so minute that the polysynthetic lamellæ can hardly be discerned. Finally, we may mention amongst the constituent minerals of this andesite large and irregular sections of magnetic iron, which usually appear as skeleton crystals.

To andesite must be referred also the rock forming veins in the trachyte of the hill known as "Crater of an old volcano." Darwin[1] thus describes the very numerous veins in the earthy trachyte exposed on the sides of this mountain. The rock forming them contains crystals of glassy felspar, some black microscopic grains, and small stains of a dark tint. The ground-mass is very hard and compact, and the rock is more

[1] Darwin, Geol. Obs., pp. 44–45.

brittle and less fusible than the trachyte which encloses it. The veins vary much in thickness, measuring sometimes only a tenth of an inch, at others exceeding an inch. The surface is rough, and the veins are either horizontal or inclined at any angle; they are generally curvilinear, and cut each other. Being hard and compact, the veins do not weather so quickly as the surrounding rock, and they frequently project for one or two feet above the surface of the ground for several yards at a time. The rock composing them is very sonorous, and vibrates when struck; the fragments lying on the ground clink like iron when thrown against each other. The shapes assumed are sometimes singular; Darwin observed a pedestal of earthy trachyte covered with the veiny rock so as to resemble a parasol large enough to shade two persons. He points out, in order to explain these facts, that the hill in question shows numerous jasperoid and siliceous veins, indicating that in this region there is an abundant deposit of silica. He admits that the rock differs from trachyte only in its greater hardness and brittleness and its less fusibility, and that probably the veins originated from the infiltration or segregation of silica much as oxide of iron accumulates in certain parts of sedimentary rocks.

Amongst the specimens collected by Dr. Maclean there is a fragment labelled "Piece of Clinkers,"[1] of which the name and all the characters correspond to Darwin's description of the veins of sonorous rock of the "Crater of an old volcano." This rock is entirely penetrated with limonite; it breaks in little plates 2 centimetres in diameter, with an unequal surface, which scales off, is fusible with difficulty, and resounds when struck. None of the constituents can be detected by the naked eye on account of the complete impregnation with iron oxide.

Under the microscope the rock presents certain analogies to the basalts from its structure, but the mineralogical composition shows it to belong to the pyroxenic andesites. The ground-mass is made up of little entangled crystals of augite of a nearly violet colour, with microliths of felspar and grains of magnetic iron. Embedded in this there are pretty large crystals of felspar and augite. The vitreous base, so common in andesites, is wanting; but, on the other hand, there is no trace of olivine, so that in spite of the basaltic appearance when under the microscope the rock is rather a transition to andesite. An examination of the felspar contained in it leads to the same conclusion. This mineral is twinned according to the albite and pericline laws, and sometimes after the Baveno type. Sections cut parallel to M show a more basic central nucleus, which extinguishes at $-7°$. They are bounded by a colourless zone, hence the plagioclase is probably an andesine, not a labradorite or bytownite. We know that andesine is almost never the felspar of basalt, and recent optical researches go to confirm the opinion of the older lithologists, who considered it characteristic of andesites. Some sections twinned according to the albite law have extinctions of which the

[1] According to the label this specimen comes from Southwest Bay.

double angle hardly exceeds 10° as a mean. We have just said that several of the plagioclase crystals showed a zonary arrangement: the interior zones have more faces than those on the periphery. This fact seems to indicate that the plagioclastic mixture was modified during the growth of the crystal. The largest crystals of augite are greenish, as is generally the case in pyroxenic andesites; they are sometimes twinned according to the ordinary law, and the mineral here presents a very pronounced prismatic form. The augite is generally altered and coloured brownish yellow by iron. The little microliths of plagioclase in the ground-mass are, like their larger congeners, usually twinned according to the albite law, and related by their extinction—which takes place at very small angles—to the microporphyritic plagioclases.

The examination of another specimen of pyroxenic andesite has enabled us to make observations which confirm what has just been said. As in the preceding specimen, the microscope showed the ground-mass to be composed of an accumulation of plagioclastic and augitic microliths and small sections of magnetite. In this mass there were large plagioclases, some of which gave good opportunities for studying their characters; others, on the other hand, formed irregular grains composed of colourless granules, as if the crystals had been crushed; and others were much corroded by the action of the magma, presenting curves and sinuosities in outline in place of the right lines of crystalline faces. This corrosion has been followed by a deposit of inclusions, surrounding the nucleus which has resisted solution. After the corrosion and deposit of inclusions a fresh deposit of plagioclastic substance, of a more basic character than that

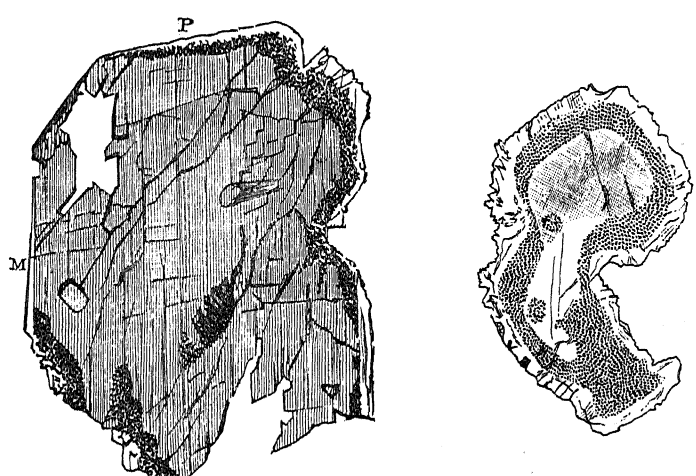


Fig. 11.—Andesite of Ascension. Sections of plagioclase corroded by the magma, with a zone of small scales of hematite; the external felspathic zone is labradorite, the internal part of the plagioclase is more acid, the extinctions of which are those of andesine. $\frac{1}{20}$ crossed nicols.

forming the nucleus, took place. Indeed this very thin external zone, which closely follows all the contours of the primitive crystal, extinguishes at an angle of about 16°

(the angle of some labradorites) in sections parallel to *M*, and the internal part at an angle of 10°. Sections perpendicular to the edge *P*/*M* extinguish at 20° for the central part, and at 30° for the outer zone. These observations confirm our previous statements, that the central crystal is andesine, the enveloping pellicle labradorite (see fig. 11). We may add that many of the crystals, even the microliths of the ground-mass, show the Carlsbad twin. The smallest plagioclastic microliths have the extinction of labradorite, the second generation of felspar is then more basic than the first.

Ejected Fragments of Amphibolic Granite, Granitite, Diabase, and Gabbro.

Darwin[1] observed heterogeneous fragments of rocks included in the scoriaceous volcanic masses of Green Mountain, and his description of these may be recalled here. Nearly all the specimens had a granitic structure; they crumbled readily, were rough to the touch, and their original colour was altered. Darwin classed these fragments, and grouped them as follows:—

1. A whitish syenitic rock, striped and spotted with red markings. Felspar is well crystallised, and numerous small brilliant grains and crystals of quartz are visible. The felspar and hornblende were determined by means of the reflecting goniometer, and the former mineral appeared from its cleavages to belong to a potash felspar. The quartz was determined by the blowpipe.

2. A fragment of a brick-red colour, composed of felspar, quartz, and dark particles of an altered mineral, which appears from its cleavages to be hornblende.

3. A mass of whitish felspar crystallised in a confused manner and containing small cavities filled with a decayed mineral, dark in colour, with rounded edges, shining fracture, but no definite cleavage plane. Comparison with the preceding specimen justifies the conclusion that it is fused hornblende.

4. A rock which appears like an aggregation of large crystals of dark-coloured labradorite, amongst which granules of whitish felspar, numerous micaceous lamellæ, and altered hornblende are found, but quartz is absent.

Darwin states also that he picked up at another point a conglomerate containing small fragments of granite, of cellular or jasper-like rocks, and of porphyry, enclosed in a wacke traversed by many fine threads of concretionary pitchstone passing into obsidian. These beds are parallel, gently undulating; they continue for only a short distance, thinning out at the extremities like the lenticular enclosures of quartz in gneiss. He adds that it is possible that these fragments were not thrown out separately by the volcano, but that they were brought to light enclosed in a fluid mass resembling liquid obsidian.

Amongst the specimens we have examined there are several which may be referred

[1] Darwin, Geol. Obs., pp. 40–42.

to crystalline rocks of the ancient type, and which have, as Darwin states, been torn up from the depths by eruptions of basalt or trachyte. We shall describe them in detail, commencing with those from Green Mountain, the locality of Darwin's specimens just described.

Amphibolic granites occur amongst the fragments brought to light by recent volcanic masses. They resemble the granitic rocks we shall describe as enclosed in the augitic andesites of Camiguin. The specimens are rather brittle, and are composed of vitreous-looking grains. The felspathic mass is milk-white, dotted with the projecting black points of little crystals of hornblende, which also line the walls of small geodes. To the naked eye the rock presents the fritted appearance we will describe in speaking of the granitic inclusions in the volcanic rocks of Camiguin. Under the microscope the texture is distinctly granitoid; numerous felspathic sections may be observed, and a few of hornblende and quartz. The sections of felspar are often twinned according to the Carlsbad law. The intercalation of plagioclastic lamellæ, which do not fail to appear in triclinic felspars, is not observable. The sections, however, do not show the homogeneity of ordinary sections of orthoclase; those parallel to the face *M* are furrowed with little veins slightly expanded in the middle. These short veinules are ranged in lines in the direction of the prismatic cleavage. On measuring the angles of extinction on a section parallel to *M*, it is found that the principal individual (that in which the veinules are imbedded) extinguishes at $+5°$, the value of extinction for orthoclase on this face. The spindle-shaped veinules, on the contrary, have an extinction of the same sign, but much greater, the angle attaining $18°$, the extinction of albite. We may conclude that this felspar is orthoclase, including fine lamellæ of albite (see fig. 12). This determination as microperthite is again confirmed by the fact that we have never been able to detect in any of the felspathic sections the intercrossed lamellæ of microcline. The innumerable gas enclosures with which the sections are riddled, giving a scorified appearance to the mineral, seem to characterise this felspar, and perhaps to indicate the high temperature to which it was exposed during its transport by the molten lava. With the exception of this the sections of felspar show only very slight traces of modification. Hornblende presents itself in irregular sections. They are very pleochroic:

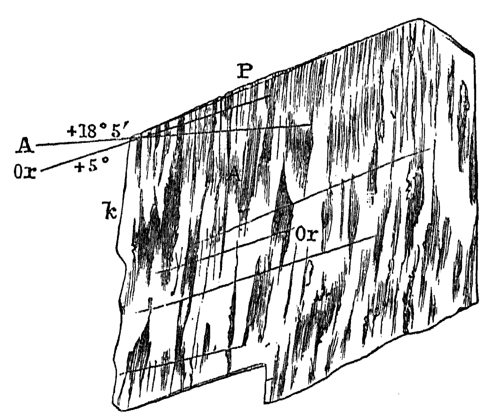


FIG. 12.—Amphibolic granite. Section of orthoclase with veinules of albite ranged in lines following the prismatic cleavage (microperthite). $\frac{1}{40}$ crossed nicols.

β >	γ >	α
almost black.	dark green.	brownish yellow.

Were it not that there are certain sections showing the characteristic cleavages of hornblende to guide us, we might hesitate in some cases to classify these green sections with this species. Sometimes they may almost be mistaken for indented plates of mica; in other cases, when they are not lamellated, they are more like a mineral of the clintonite group; but the cleavages are certainly those of hornblende. Quartz has crystallised last. The sections of this mineral are cracked in a remarkable way, each forming a true breccia, the fragments of which are surrounded by a black border. The cracking conveys the idea that the mineral has been splintered by the action of heat. Another peculiarity of the quartz in this granite is the number and size of its inclusions. They are relatively very large, often presenting the form of a negative crystal, containing gas-bubbles and a liquid; sometimes they contain some small well-known cubic crystals. In this respect we may compare the inclusions with those of quartz in the rocks of Laurwig. Enclosed minerals are rarely found in these quartz sections; we may, however, mention fine needles of schorl occurring as inclusions. Finally, amongst the constituent minerals there are small sections of somewhat irregular form which, from the index of refraction, the colours with polarised light, and extinction, seem to be zircon.

Another fragment from the same locality is referable to granitite; it appears to the naked eye with the texture of a porphyritic granite, and the shining crystals of orthoclase may attain 2 or 3 centimetres in diameter. Black mica appears scattered through the ground-mass, giving it a slightly gneissose structure. As in the case previously given, the large felspathic sections are microperthite; sections of micropegmatite are occasionally found, and more rarely the felspathic element is plagioclase, which presents at the same time the twin of albite and that of pericline. The black mica is very dark biotite, which often forms little nests, or the lamellæ are intercalated between the various constituents. Zircon sometimes occurs included in quartz, the crystals being comparatively large.

We shall now describe another rock resembling that last treated of in some respects, although the black mica is not so abundant. The texture is granitic, but the specimen is much altered, being entirely penetrated by iron oxide, which gives it a reddish colour. The naked eye can only distinguish felspar with rather bright cleavage faces. The rock, so far as one can examine it with the microscope, is impregnated with hematite, which has infiltrated into all the interstices and cleavages, and appears in isolated scales of indistinctly hexagonal outline. Felspar is represented by orthoclase and plagioclase. The orthoclase has often crystallised as a Carlsbad twin, but the plane of composition seems to be *k* in place of *M*. The plagioclases present no feature which is not common to the monoclinic felspar with which they are associated; the sections are riddled with gaseous and vitreous inclusions. The constancy with which these inclusions occur in the felspar of all those rocks that have been carried along by

lava, seems to show that igneous action has had something to do with the development of the inclusions. The form of the grains into which the quartz sections are divided shows clearly that the parts belong to one large individual. The cause just invoked to account for what may perhaps be termed the scorification of the felspar probably produced this cracking of the quartz. Sections of micropegmatite are less common than in the granitite previously described, but they sometimes appear. Besides the rare scales of biotite, there are some small crystals of hornblende; these are almost colourless, but some sections with the characteristic cleavage show incontestably that they are amphibolic.

Other specimens of older rocks from Green Mountain must be classed with diabase, although, as we shall see, the micro-structure is not altogether identical with that of rocks of this type. These fragments are very much altered, and easily crumble down. The naked eye distinguishes felspar, biotite, and a granitoid structure. The microscope shows that the rock is formed of an aggregate of plagioclastic lamellæ, augite, and biotite, with hornblende as an accidental constituent. The triclinic felspar shows extinctions which lead one to believe it to be labradorite. The augite shows itself in excessively broken-up sections, formed of an accumulation of irregular granules. The grains of augite do not appear to result from fractures along the lines of cleavage; the mass rather resembles a crushed crystal. Fibrous hornblende appears between the grains, and shows itself most clearly at the extremities of the pyroxenic sections, where it may be seen to pass into black mica. The augite is greenish in colour, and more like that of diorite than of diabase. The lamellæ of biotite are often twinned, the limit of the twin being parallel to the lamellæ; the composition plane is probably the pinacoid $0P$. Grains of augite sometimes appear associated with biotite; in this case it is not uncommon for the former to be oriented with the vertical axis parallel to the lamellæ of this mica. Hornblende, which is rather rare in the preparations, is only distinguishable from biotite in ordinary light by its structure, and by a decided prismatic cleavage. Sometimes, when this mineral borders augite, it is fibrous. Finally, we note the transparent prismatic crystals of a mineral which appears grey from the number of inclusions it contains. It would be classed as cordierite if its colours with polarised light were a little more vivid; perhaps it is an altered felspar.

At Red Hill, as at Green Mountain, fragments of old rocks are found which have been brought up by recent eruptions. The specimens from Red Hill may be classed with the gabbros, and microscopic examination shows them to be olivine gabbros. The rock has to the naked eye a granitoid texture; in colour it is reddish, being impregnated with limonite. Triclinic felspar is distributed through the mass in the form of grains, and is intimately associated with a pyroxenic mineral. The elements of this rock measure about 5 millimetres in diameter.

Under the microscope the structure of olivine gabbro is brought out. Elongated lamellæ of plagioclase, containing between them sections of augite moulded on the associated elements, do not appear here; the felspar is in large sections of irregular outline, in very rare cases assuming a form more or less resembling a parallelogram. The symmetrical extinctions, measured on sections more or less nearly parallel to the face *k*, give values of from 36° to 40° on each side of the albitic lamellæ. These extinctions have been measured on sections showing at the same time lamellæ of albite and of pericline crossing at an angle of about 80°, the sections being thus sensibly parallel to *k*. For sections of the zone $P:k$, which give symmetrical extinction, the angle only varies from 12° to 20° on the average. These values indicate in each case a very basic felspar, almost a mixture of bytownite and anorthite. This determination agrees both with the form this felspar assumes here and with the nature of the rock in which it occurs. It is known that the plagioclase of the Neurode gabbro, for instance, is anorthite.

Plagioclase isolated from the rock has been analysed by Dr. Klement, with the following result:—

I. 1·2166 grammes of the substance dried at 110°C, and fused with the carbonates of soda and potash, gave 0·6203 gramme of silica, 0·3708 of alumina, 0·0134 of ferric oxide, 0·1751 of lime, and 0·0030 of magnesium pyrophosphate.

II. 0·5398 gramme of the substance treated with hydrofluoric acid gave 0·0405 gramme of potassium and sodium chlorides, and 0·0058 of potassium chloroplatinate.

PERCENTAGE COMPOSITION.

Silica, SiO_2,	50·99
Alumina, Al_2O_3,	30·48
Ferric oxide, Fe_2O_3,	1·10
Lime, CaO,	14·39
Magnesia, MgO,	0·09
Soda, Na_2O,	3·80
Potash, K_2O,	0·21
	101·06

The results of analysis given above confirm the optical determination. The mixture, in fact, corresponds in composition to 30 per cent. of albite and 70 per cent. of anorthite, which is—

Silica, SiO_2,	50·68
Alumina, Al_2O_3,	31·73
Lime, CaO,	14·05
Soda, Na_2O,	3·54
	100·00

The sections of olivine are much altered on the edges; they are sometimes transformed into red hematite, and trichites penetrate them in every direction. That the trichites are of secondary formation is made evident by the fact that they are developed in the interstices between fissures, and sometimes follow the curves marked out by the latter.

Augite is often lamellated as it appears in some diabases. The lamellæ are produced by the repetition of twinned individuals interposed parallel to the pinacoid $\infty \bar{P} \infty$. The nature of this mineral confirms our determination of the rock. The absence of cleavage in these pyroxene sections is striking—they are rarely furrowed by the regular fractures so common in this species, but this peculiarity may be due to the unusual thickness of the microscopic preparation submitted to examination.

Another specimen of a similar rock contains a very basic plagioclase, as in the preceding case, and also greenish augite, but there is no olivine, its place being taken by some rare sections of a rhombic mineral. These might be mistaken for olivine by ordinary and by parallel polarised light. The sections are colourless, but brilliantly coloured in polarised light; they stand out in high relief, the outlines being blunted and the surface shagreened. They are, however, distinguishable from olivine by the presence of extremely fine black linear inclusions, running parallel to each other and to the length of the sections, and sometimes assuming the form of negative crystals. Extinction takes place parallel and perpendicular to these inclusions and to the traces of faces of the zone of the prisms. In convergent light it becomes apparent that this mineral should be classed with the rhombic pyroxenes, such as enstatite. The determination as enstatite is confirmed by the use of the condenser, which enables one to distinguish an eccentric optical axis so situated as to show that the plane of the axes is parallel to $\infty \breve{P} \infty$.

Veins and Siliceous Infiltrations.

In his geological description of Ascension, Darwin[1] calls attention to the numerous veins of siliceous material which cut through the rocks of the "Crater of an old volcano." These veins he described as white, composed of a material with low specific gravity and conchoidal fracture. The colour sometimes becomes reddish; in other cases it is yellowish white and the fracture angular, while a whitish powder fills the cavities. Both varieties occur as amorphous masses in the altered trachyte, or as wide irregular veins coloured red and running vertically or in a tortuous manner. This rock, which resembles sandstone in appearance, is nothing but an altered trachyte. Jasper of an ochreous colour is found in large masses, and occasionally in the form of veins enclosed in altered trachyte, or in scoriaceous basalt. The cavities of the latter rock are lined

[1] Darwin, Geol. Obs., p. 45.

or entirely filled by concentric layers of chalcedony coloured red by ferric oxide. Irregular angular grains of red jasper, with an outline gradually becoming less definite and passing into the surrounding mass, are found in the most compact parts of the same rock; there are also other grains which hold a position intermediate between jasper and decomposed iron-coloured basalt. The jasperoid portions contain circular cavities of exactly the same form as those occurring in scoriaceous basalt. Darwin explains these facts by supposing a siliceous solution to have penetrated the rock after the elimination of certain altered constituents. This interpretation appears very natural, but with the specimens at our disposal, it would be rather difficult to judge of its applicability; we would require to see many more specimens than those we have studied. With reference to these siliceous deposits, Darwin recalled the frequency with which a similar action occurred amongst the altered trachytic tufas.

Amongst the specimens collected by the Challenger, we have only found a few fragments showing the siliceous infiltration to which reference has been made. Some rocks from Riding School, and from the plain at the foot of Red Hill, show silicification well. In proportion as silica develops in the rocks, the characters of the constituent minerals become obscured, and various modifications of silicic acid invade the ground-mass.

One of the rocks from Red Hill is a true siliceous tufa, in which the original constituents can hardly be distinguished. The rock is yellowish white to the naked eye, decayed, so hard that steel will not scratch it, and milky fragments of quartz break off from the mass. Under the microscope the ground-mass is seen to be nothing but an aggregate of minute quartzy grains firmly compacted together. They are angular and colourless, and behave between crossed nicols like the basis of certain quartziferous porphyries.

A volcanic glass almost entirely converted into silica is found at Riding School. This rock is like a eurite, whitish in colour, very hard, homogeneous in texture, and has a slightly scaly fracture. Microscopic preparations show a slightly vesicular vitreous ground-mass. Chalcedony has formed in the pores and interstices of this glass, and in some places the rock seems impregnated with imbricated crystals of tridymite.

Siliceous Deposits of Organic Origin.

The wide circular hollow, about half a mile in diameter, which surmounts the "Crater of an old volcano," is not a crater according to Darwin.[1] The hollow is almost filled with many-coloured layers of scoriæ, cinders, and incoherent volcanic products. The general appearance of the beds is saucer-shaped. They are all visible at the edge of the hollow, where they show as a succession of variously-tinted rings, giving a

[1] Geol. Obs., pp. 47–49.

singular character to this eminence. The outer ring is large, distinguished by its white colour and its resemblance to a racecourse,—hence the name of Devil's Riding School. According to Darwin these beds of ashes must have covered the whole region formerly, but they have been dispersed by wind—those which had fallen into the hollow on the summit were sheltered, and became to a certain extent cemented and consolidated by rain. One of the beds has a rosy colour, and is formed essentially of small fragments of pumice. It contains numerous concretions, which are spherical and vary from half an inch to three inches in diameter; sometimes they are cylindrical, like the concretions of pyrites in the chalk. These concretions are formed of six or eight clearly-defined concentric layers, separated by colourless zones, and surrounding a nucleus which appears to be homogeneous. The central part is often traversed by fissures like those of septaria; these are bordered by black veinules, which sometimes assume a metallic aspect, or by white patches. Amongst the largest concretions, some were found which simply formed a spherical shell full of incoherent volcanic ashes. These concretions contain only a small proportion of calcium carbonate. Before the blow-pipe a fragment crepitates, whitens, fuses into a frothy enamel, but does not become caustic. The mass enclosing the nodules contains no trace of calcium carbonate. Darwin adds that he never met with a description of similar nodules, and what rendered them the more remarkable, in his estimation, was their hardness and compactness, which must have been acquired under the influence of atmospheric water alone.

So far, with regard to these concretions, we have only cited Darwin, whose description corresponds very exactly with the facts he observed. At the time of publishing his book on Volcanic Islands, he considered these spheroidal concretions, and the material with which they were associated, as exclusively made up of incoherent volcanic products. After his voyage he submitted a specimen of the concretions to Ehrenberg. Microscopic examination showed that it did not present the characters of ordinary volcanic ashes, but that the rock was only an accumulation of particles of organic origin. According to Ehrenberg, these particles are not very much modified, although they no longer contain any compounds of carbon. He attributed the elimination of these bodies to the action of heat. He did not admit that these organisms periodically accumulated in the hollow, as it would be necessary to suppose if they lived where their remains were discovered. The whole mass was apparently formed of organic débris, and Ehrenberg observed 30 species of siliceous organisms in the deposit. He even considered the more or less amorphous matter which is associated with the particles as being exclusively composed of this siliceous débris in a state of dust. These organisms all belong to fresh-water forms, the greater number of small siliceous particles being derived from grasses. It is very remarkable that no marine forms have been discovered on this island. In concluding his

paper, Ehrenberg rejects the idea that this deposit is the residue of the vegetation of the island.[1]

Darwin in his Voyage of a Naturalist modified his first explanation of this deposit, and stated the results of Ehrenberg's examination. After mentioning that Ehrenberg considers this siliceous matter to have been ejected in its present state from the volcano, he states that the appearance of the layers has led him to believe that they were deposited under water, and considering the extreme dryness of the climate, he has been compelled to suppose that torrents of rain had probably accompanied some great eruption, and that a temporary lake was thus formed in which the ashes were laid down. Perhaps one might now be justified in supposing that the lake was not temporary. Although it were so, we may be quite sure that at some earlier period the climate and productions of Ascension were quite different from what they are now.

The specimens of white earth and the concretions from the Devil's Riding School, which we have examined, correspond with Darwin's macroscopic description, and, in general, with what Ehrenberg said of their microscopic constitution. Amongst the specimens we have studied three varieties occur; two of these are concretionary, and both pass into the third by insensible gradations. The common variety is a pulverulent earthy rock, soiling the fingers, and to the touch resembling mealy diatomaceous earth; the colour is yellowish white, inclining to pink. This variety is associated with the spherical concretions of which Darwin speaks; these are embedded in the mealy mass. The nodules we have examined are from 1 to 3 centimetres in diameter. They are built up of concentric zones sometimes with radial fissures; spherical coatings easily peel off, but the central part is more compact. Two nodules are sometimes joined; in other cases they bear the marks of small depressions. Except for their rather large size, analogies are not wanting with certain pisoliths or globular forms sometimes assumed by volcanic ashes. These globules are not generally very coherent, but the third variety differs in this respect. In it the concretions are more irregular, assuming discoidal, cylindrical, even coral-like forms; the surface alone is earthy, the internal part being compact, and so hard that steel will hardly scratch it. All the particles which make up the interior zones are strongly cemented, and coloured brown by iron. We may add that some of these nodules bear a great resemblance to some flint concretions of the chalk. A summary analysis showed that the material contained about 87 per cent. of silica, and that the loss by heating was 6 per cent.

The various forms of this siliceous substance have the same microscopic composi-

[1] Ehrenberg, Ueber einen bedeutenden Infusorien haltenden vulkanischen Aschen Tuff (Pyrobiolith) auf der Insel Ascension (*Berichte d. k. Akad. d. Wiss. Berlin*, 1845, p. 140). Taking account of the name (Pyrobiolith) which Ehrenberg gives to the deposit, and the conclusions he expresses in his memoir on the infusorian volcanic tufas of the Rhenan country (*loc. cit.*, Bd. vi. p. 133), it is evident that he considers these deposits as of internal origin, and brought to their present position by eruptions.

tion. The dust of the earthy variety, and the slices of the concretionary, are filled with elongated colourless forms, more or less rounded, and slightly curved; these are undoubtedly organic and siliceous; they are the débris of the organisms which Ehrenberg discovered and determined. These particles are enclosed in a pale yellowish isotropic matrix without definite outline. When this opaline ground-mass is more coherent, one sees that the rods and colourless organic forms appear as partly dissolved; the ground-mass is more homogeneous, and the interstices are lined with microscopic grains of quartz. Splinters of glass, lapilli, or minerals of volcanic origin are rarely seen.

Ehrenberg's explanation does not seem to apply here; there is nothing to indicate an eruptive origin for the siliceous earth and its nodules. It seems more reasonable and more probable to admit that the cavity containing the deposit in question was formerly a crater-lake, in which the remains of fresh-water organisms accumulated; part of the constituent silica was dissolved, perhaps under the influence of thermal springs, and cemented the particles which in aggregating took in some cases the form of nodules.

Calcareous Rocks Forming on the Coasts.

Darwin describes calcareous rocks in process of formation at several points on the coast of the island.[1] The shore is covered with immense numbers of minute rounded particles of shells and coral, white, yellow, and red in colour, mixed with rounded volcanic minerals and splinters. At a depth of some feet the particles are cemented, and form a compact rock, the softest kind of which is used for building, while some varieties are too hard for this purpose. One of these calcareous masses was observed divided into horizontal layers half an inch thick; it gave a ringing sound like flint under the hammer. The people of the island believe that one year suffices to cement the calcareous sand into stone. The sand is united by a calcareous cement, and one can always observe, even in the most compact varieties, a zone of crystalline calcite around every fragment of shell and each volcanic grain. Lyell[2] states that turtles' eggs deposited in this calcareous and volcanic sand are sometimes subjected to the same process, and are found enclosed in the mass. He has figured some eggs containing the bones of young turtles that were included in this way in these recent calcareous rocks. Darwin treated a specimen of the rock of specific gravity 2·63 with acid, and found that it dissolved entirely with the exception of a little flocculent organic matter.

A great accumulation of calcareous particles takes place annually on the shore near

[1] Darwin, Geol. Obs., pp. 49, 50.

[2] Lyell, Principles of Geology, Book III. chap. xvii., as cited by Darwin; in Lyell's edition of 1872, see vol. ii. chap. xlviii. p. 581.

the Residence in the beginning of October, the sand being driven towards the south-west. According to Lieutenant Evans, this is accounted for by a change in the prevailing direction of the currents. During this period the rocks exposed to the tide on the south-west are gradually covered by a calcareous incrustation, the thickness of which may attain half an inch. This coating adheres strongly to the rock, is white in colour, and at some points laminated, but after the lapse of a certain time it disappears; perhaps it is re-dissolved by the sea water, perhaps worn away by the waves. Lieutenant Evans, who communicated these observations to Darwin, had had opportunities of studying the phenomena during six years which he spent at Ascension. The thickness of the layer varied from year to year; in 1831 it was exceptionally great. When Darwin landed in June 1839, he could only see it at one point above a basaltic rock from which the quarrymen had raised a block of limestone. On taking into account the position of the rocks exposed to the tide, and the period at which they are covered with the calcareous coating, one comes to the conclusion that the sea water, continuously in contact with the particles of broken shells on the beach, takes up an excess of calcium carbonate, and then on evaporation deposits it upon the rocks over which the waves wash. According to information given to Darwin by Lieutenant Holland, this incrustation is found on the rocks of the coast in several parts of the island.[1] The formation of this deposit must be explained by the solvent action of sea water on the shelly formations of the shore, and the rapid evaporation of the water.

The specimens of these oölitic rocks which we have examined come from the west coast, and vary greatly in coherence. Some are scarcely compact, the fragments of shells and minerals being simply brought together without the aid of calcareous cement; others are massive, very coherent, and hard, showing a compact ground-mass in which the naked eye can detect the pink or white organic particles mixed with black volcanic grains.

Microscopic observation shows that the fragments cemented together by calcareous matter are all perfectly rounded, the elliptical form sometimes prevailing. They are composed of the remains of shells and other organic débris, and are distinguished from

[1] Besides this deposit and the rocks formed of shell fragments, Darwin describes a calcareous incrustation presenting a special structure. It also covers volcanic rocks exposed to the tide. We have found nothing amongst the specimens to correspond to the description and figure he gives in his book on Volcanic Islands, p. 51. We refer to the passage where the author enters into very precise details on the subject of this layer, the form of which closely resembled an organic structure. He considers it due to the same cause as the cemented limestone and incrustations of the coast. In the analysis he made of the concretionary incrustation of Ascension, calcium sulphate was found; this might come from evaporated sea water. He adverts to Dr. Webster's description (Voyage of the "Chanticleer," vol. ii. p. 319) of beds of gypsum and salt, 2 feet thick, on rocks exposed to the prevailing wind. Fine gypsum stalactites, resembling those of carbonate of lime, may be seen there. In the caves of the centre of the island amorphous masses of gypsum are found, and in an old crater on Cross Hill the salt appears traversing the scoriæ. In this case Darwin considers the sea salt and gypsum as of volcanic origin (see Darwin, Geol. Obs., p. 53, footnote).

the calcite cementing them, by their internal structure, semi-opacity, and greyish tint. The internal structure of the fragments is generally well preserved; sometimes they present a spathic cleavage, and at others the calcium carbonate composing them is very fibrous. Yet, as examination in convergent light shows, it is impossible to refer these fibrous sections to aragonite. With the condenser, one arm of the cross of monaxial crystals may be seen. The rolled fragments of inorganic origin cemented together with the shell sand are the débris of volcanic minerals or rocks. The latter are most frequently represented by rounded spangles of plagioclastic felspar, often by grains of olivine, but augite is rather rare. The lapilli, or rolled fragments of rocks, belong generally to the family of basalts. They are scoriaceous, often vitreous, and transformed into palagonite with vesicles lined with zeolites. Rolled fragments of trachytic rocks rarely occur in this limestone; this may be accounted for by the fact that basalt chiefly occurs on this side of Ascension. The rocks and minerals enclosed in the calcite are all somewhat profoundly altered. The substance cementing these heterogenous fragments is always calcium carbonate, perfectly transparent and fibrous; this distinguishes it at the first glance from the included shell-particles. The fibres are so fine that it is impossible by optical means to determine whether they are calcite or aragonite; the polarisation colours and the irisation are the same as for calcite. The calcareous coat which envelops each of the rolled grains is sometimes fibro-radiated, the fibres spreading from one grain to the sides of the zone surrounding the contiguous fragments. The calcareous matter sometimes does not fill all the interstices, and the resulting little geodes, sometimes of triangular form, bristle with a fine lacework of rod-shaped crystals of calcium carbonate.

In conclusion, something must be said about a shining coating of calcium phosphate which clothes some of the rocks of Ascension. In his description of the rocks of St. Paul, Darwin drew attention to an enamel coating which covered the cliffs of that islet. We have described and analysed the material which Darwin found at St. Paul's Rocks, and compared it with the substance coating the rocks of Ascension. Darwin, describing this glossy incrustation, says: "Extensive portions of these rocks are coated by a layer of a glossy polished substance, with a pearly lustre and of a greyish-white colour; it follows all the inequalities of the surface, to which it is firmly attached. When examined with a lens, it is found to consist of numerous exceedingly thin layers, their aggregate thickness being about the tenth of an inch. It is considerably harder than calcareous spar, but can be scratched with a knife; under the blowpipe it scales off, decrepitates, slightly blackens, emits a fetid odour, and becomes strongly alkaline: it does not effervesce in acids. I presume this substance has been deposited by water, draining from the birds' dung with which the rocks are covered. At Ascension, near a cavity in the rocks, which was filled with a laminated mass of infiltrated birds' dung, I found some irregularly-formed stalactitical masses of

apparently the same nature. These masses when broken had an earthy texture, but on their outsides, and especially at their extremities, they were formed of a pearly substance, generally in little globules, like the enamel of teeth, but more translucent, and so hard as just to scratch plate-glass. This substance slightly blackens under the blowpipe, emits a bad smell, then becomes quite white, swelling a little, and fuses into a dull white enamel; it does not become alkaline; nor does it effervesce in acids. The whole mass had a collapsed appearance, as if in the formation of the hard glossy crust, the whole had shrunk much."[1] Darwin states in a note that when he described this substance in his Journal he viewed it as an impure calcium phosphate.[2] We have tested some small fragments of the incrustation collected at Ascension; there remains no doubt as to this being the true interpretation. The coating gives the reactions of phosphoric and sulphuric acids, and the microscopical characters resemble those of the incrustations on St. Paul's Rocks.[3] It may therefore be admitted that it was formed, like the latter, by the decomposition of the excrement of birds. In his description of Ascension, Lesson was the first to lay stress on the accumulation of birds' droppings which covered the rocks of the island. The insoluble residue exposed to the rays of the sun and the action of waves has hardened, and forms the coating which clothes the rocks of the coast.[4]

VI.—NOTES ON THE ROCKS OF THE TRISTAN DA CUNHA GROUP OF ISLANDS.

Until the Challenger Expedition explored these islands, we had only very uncertain notions of the nature of the rocks that constitute the group of Tristan da Cunha. We have borrowed from the Narrative, vol. i., and the works of Sir Wyville Thomson[5] and Moseley,[6] and especially from Buchanan's report,[7] the local details that accompany these lithological researches. The following observations do not form a complete geological monograph of the Tristan da Cunha group; in general, they have reference only to the

[1] Darwin, Geol. Obs., pp. 32, 33. [2] *Ibid.*, p. 33.

[3] See A. Renard, Report on the Petrology of the Rocks of St. Paul, p. 18 (*Narr. Chall. Exp.* vol. ii. Appendix B). We give there a micrographic description and analysis of these layers and veinules of calcium phosphate. The incrustation Darwin saw at St. Paul's, which he compares to that at Ascension, is described on p. 21 of our memoir. On analysing a specimen we found phosphoric acid (P_2O_5), 33·61, and lime (CaO), 50·51, besides traces of iron, manganese, and sulphuric acid. This incrustation can thus be viewed as tribasic calcium phosphate with calcium sulphate, and perhaps carbonates of lime, magnesia, and iron (see Darwin, Voyage of the Beagle, chap. i. p. 8; Buchanan in Thomson, The Atlantic, vol. ii. pp. 107, 108.) For phosphates very like those we describe, see also Phipson, *Amer. Journ. Sci.* vol. xxxvi. p. 423; Julien, *ib.* p. 242; Piggott, *ib.* 2nd Ser. 1856, No. 22.

[4] Lesson had observed this shining layer, but mistook its nature; he says, "a grey enamel-like obsidian clothes the rocks of the coast," *loc. cit.* p. 492.

[5] Wyville Thomson, The Atlantic, vol. ii. p. 152.

[6] Moseley, Notes of a Naturalist on the Challenger, p. 108.

[7] Buchanan, *Proc. Roy. Soc.*, vol. xxiv. p. 593.

rocks that crop out on the coasts. The difficulties of exploration prevented the naturalists from rambling out of sight of the ship. On considering the nature of the rocks collected, everything leads to the belief that similar conditions would have been observed in the central part of the island.

The group of Tristan da Cunha comprises the Islands of Tristan, Nightingale, and Inaccessible. On the strength of the relations of the flora, there ought to be added to the same group the small Island of Gough, lying 200 miles to the south. These islands form the summits of a great submarine chain, which traverses the middle of the Atlantic from north to south, and on which, in the southern part of that ocean, rest the St. Paul's Rocks and the Islands of Ascension and St. Helena.[1]

A. Rocks of Tristan Island.

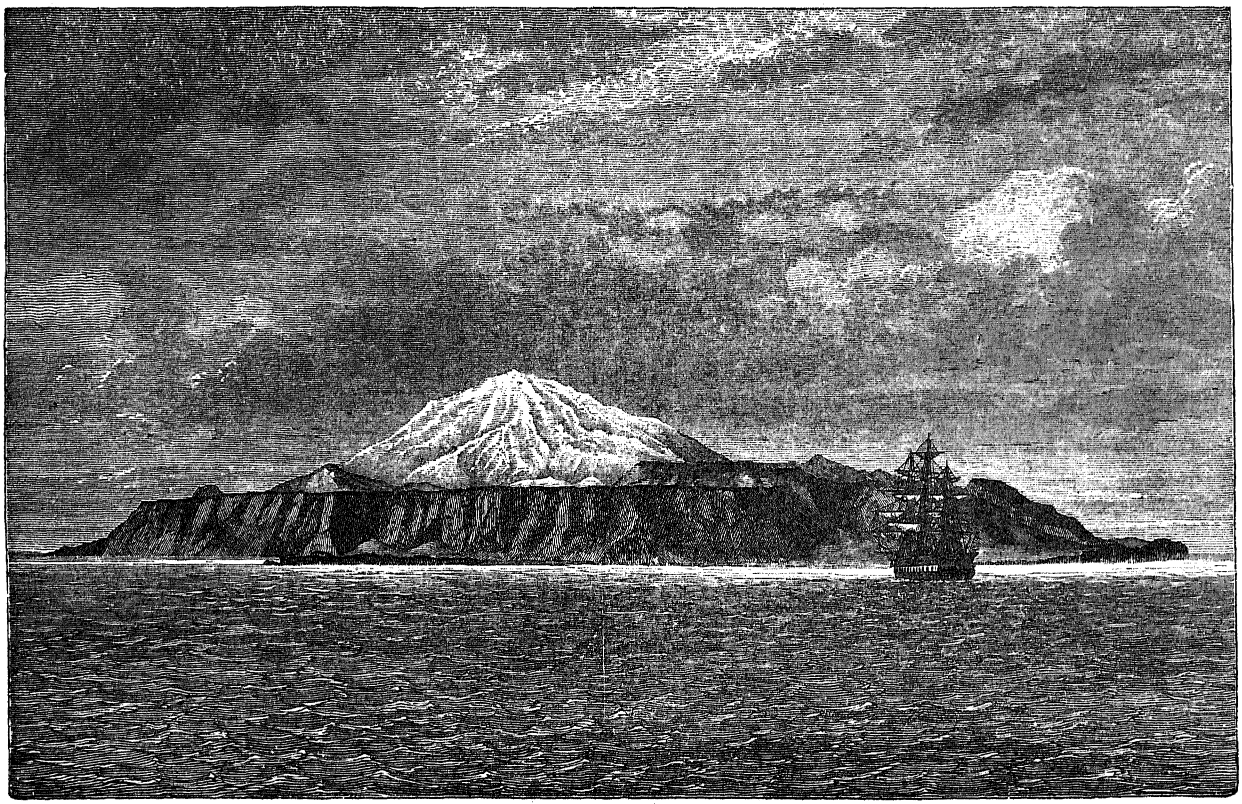
Tristan, the most important of these islands, lies in the north of the group; it is situated in lat. 37° 2′ 45″ S., long. 12° 18′ 20″ W. (Herald Point); it is 1550 miles distant from the Cape of Good Hope, 2000 miles from Cape Horn, and nearly 1320 south of St. Helena. The area is about 16 square miles. The Island of Tristan is almost circular, an elevated peak occupying the centre. If a circle of $3\frac{1}{2}$ miles radius be described with this mountain as centre, it will touch all the salient points of the coast, except those in the eastern quarter, where the shore projects about half a mile beyond the circumference. This island rises almost vertically from the bottom of the sea, the 100 fathom line occurring close to the coast; it is bordered by craggy cliffs, which render landing very difficult. The perpendicular rocks that encircle the island attain a height of 1000 to 2000 feet, and form a terrace or plateau, on which stands a conical peak, reminding one of the peak of Tenerife; its summit, covered with snow for nearly the whole year, attains a height of 7640 feet. According to the inhabitants of Tristan, the peak is a cone of black and red scoriæ, with a crater-lake on the top; the diameter of the crater is about a quarter of a mile. From the coast other eminences of less height are visible on the plateau that forms the centre of the island. These hills are very probably also secondary cones of eruption; several of them, like the central peak, have crater-lakes.

The cliffs are formed of nearly horizontal beds of basalt, alternately compact and scoriaceous, with intercalated layers of reddish volcanic tufa. The whole system of beds slopes slightly towards the shore, as can be seen to the east and west of the harbour. These beds are traversed by dykes, generally vertical and of no great thickness.

[1] Starting from the meridian of 35° W., and a little to the south of the parallel of 35° S., the bottom of the sea begins to rise gradually, till it reaches the culminating point of the submarine chain of the South Atlantic. The ground rises to the height of the Islands of Gough and Tristan da Cunha, around which soundings of 1100 fathoms and upwards have been made. To the east of the islands the bottom sinks to 2200 fathoms, between long. 10° W and 15° E., and from lat. 30° to 50° S.

Torrents and atmospheric erosion have worn gullies in these walls of rock, and heaped together piles of débris, which have accumulated to a height of 100 feet at the foot of the cliffs. This circle of volcanic fragments is, in its turn, edged by a belt of gravel of the same nature, which is spread out on the narrow shore of the island.

There is perhaps no region in the world where atmospheric agencies exert their destructive action in so energetic a manner as here. For nine months in the year terrible tempests run riot on the island, and when the season of rains has ended, and the snow that has accumulated on the top of the peak begins to melt, the water rushes

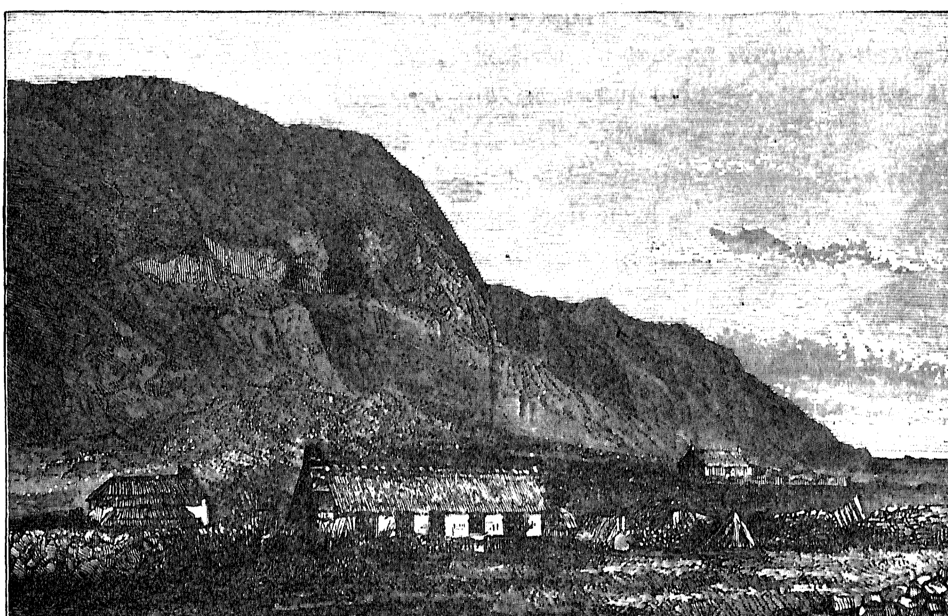


The Island of Tristan da Cunha.

down in cascades, carrying an immense quantity of débris. These streams vigorously attack and demolish the less coherent and homogeneous of the layers that form the horizontal strata; they lay bare the rocks of the dykes, and cut deep indentations in the ledge of the terrace. The transverse dykes alone resist the erosion, and stand up like walls.

Mr. Buchanan observes that at Tristan, as at Nightingale Island, the dykes have, at their contact, made the volcanic breccia which they traverse more alterable; whence it results that denudation acts by preference along their sides. These dykes of massive injected rocks also form the axis along which the coves and bends of the

shore are hollowed out. On the Island of Tristan the gully lying behind the settlement, in the centre of which the spring rises that supplies the village brook, is formed in a similar way. It is banked by a vertical dyke, the thickness of which is nearly 180 feet; this injected rock has altered the encasing beds, which have become schistose and break down readily. A large number of similar dykes can be seen in the cliffs, but their thickness does not generally exceed one or two feet. The rocks of the coast, presenting as they do good natural sections of the island, have enabled Mr. Buchanan to establish at two points the existence of old vents, occupied now by volcanic materials, which seemed to him products of subaërial eruption, slowly deposited under water. This interpretation leads to the further admission, that



Settlement of "Edinburgh," Tristan da Cunha.

certain parts of the Island of Tristan have, like several islands of the Atlantic, been subjected to upheaval.

In first describing the rocks that have been poured out as lavas, or projected as incoherent volcanic materials, and now constitute the nearly horizontal beds, we must point out, as one of the most important, a reddish yellow rock with large crystals of augite. According to the observations of Mr. Buchanan, it has undergone profound alteration under the influence of the dykes that traverse it. Some of the specimens of it are almost completely disintegrated; the augite crystals alone have resisted decomposition, and they can be extracted with ease from the almost earthy mass that encloses them.

Thin sections of certain less decomposed portions of this rock show that it ought to be referred to the felspathic basalts, passing, in some cases, to the augitic andesites. The following minerals — plagioclase, augite, mica, titanic or magnetic iron, and, in certain cases, olivine—give the rock a microporphyritic structure. The crystals of felspar give sections showing plagioclastic lamellæ following the albite type; sometimes they are twinned on the Carlsbad, the pericline, or the Baveno type. Fig. 13 shows a section of plagioclase observed in the rock in question.

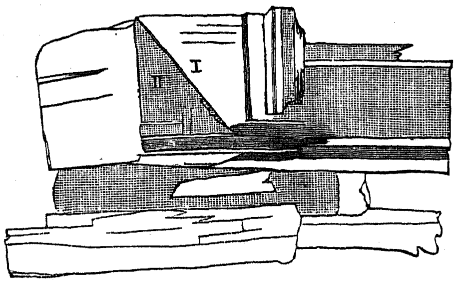


FIG. 13.—Felspathic basalt of Tristan da Cunha.
I. and II. twin of Baveno, the other twins following the pericline type, or some other analogous twinning. The plane of twinning (*n* or *e*) is at the same time the plane of composition.

The crystals of augite present no striking peculiarity. Those of olivine, which at first sight somewhat resemble pyroxene, are enclosed in a setting of small augitic crystals. The black mica plays a very subordinate part, but the ilmenite or hematite is, on the contrary, represented by large dark brown or almost opaque sections, furrowed by well-marked lines of cleavage intersecting at angles of 120°; these lines run throughout the whole extent of the section, and are often parallel to its outlines (see fig. 14). It is somewhat rare to find hematite with such clearly marked cleavage. Something analogous may be found in sections of ilmenite, but then, generally, there are needles of rutile, intercalated at constant angles. In the mineral we are describing, we have not been able to make out any inclusions of rutile.

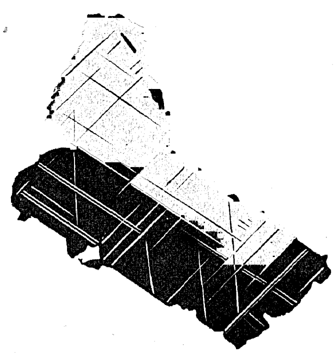


FIG. 14.—Felspathic basalt of Tristan da Cunha.
Opaque section of ilmenite or hematite with cleavages intersecting at 120°.

The ground-mass is formed of microliths of the same species, especially of felspar and augite; between these small crystals lies a vitreous base, which plays a wholly subordinate part. At certain points a yellowish limonitic matter has been deposited as concretionary masses in the pores.

Some of these decomposed specimens pass almost without gradation into a more compact and harder rock. These compact zones are black with glassy lustre and brilliant fracture; they exhibit the vitreous modification observed on the contact faces of the dykes in the same island. These black bands resemble obsidian; they are only 2 centimetres thick, and may be looked on as the more quickly cooled surface of the basaltic sheet. This glass shows under the microscope a blackish brown and sometimes nearly opaque isotropic base; at certain points it passes into the reddish modification, with the resinoid appearance of the palagonitic tufas. In this base crystals of plagioclase are seen, some sections of which give extinctions of 42°, and consist of anorthite; as usual,

this felspar is traversed by few hemitropic lamellæ. The augite sometimes contains granules of olivine, magnetite, and apatite as inclusions.

The beds formed by this altered felspathic basalt are overlaid by a basaltic tufa. The transition is effected through rocks that are richer in glassy materials, but belong, nevertheless, to the same lithological type. The tufa covering the sheet in question is formed of fragments in which the vitreous element predominates; they appear, under the microscope, to consist of a vesicular yellowish or brownish glass, passing occasionally into the hydrated, reddish, resinoid product of decomposition of certain basic volcanic glasses. The crystals that separate out from these vitreous fragments belong chiefly to greenish pleochroic augite, and are generally irregular in contour. The preparations show, besides, sections of the same mineral and of plagioclase of smaller size, with clean cut outlines embedded in the glassy matrix, and belonging to a secondary period of consolidation. Olivine and magnetite are relatively rare. Frequently the large crystals of augite and plagioclase are partly lined or entirely surrounded by a vitreous substance more opaque and blacker than the glass that forms the ground-mass.

This tufa is overlaid in its turn by a rock of the same kind, but of a coarser grain. It consists of lapilli, 2 to 3 centimetres in diameter, and is full of augite crystals visible to the naked eye. There also occur in it fragmentary crystals of olivine, which show their clastic origin very clearly under the microscope. The same remark applies also to some of the augites in this tufa. As is shown by fig. 15, the sections of these clastic minerals exhibit certain outlines which represent the crystallographic contours. These traces of faces are distinct and straight (a), and are bordered by black glass of varying thickness; but wherever this section shows fractures, this coating of black glass is absent. This furnishes evidence that the crystals in question were once entirely embedded in a dark or almost opaque glassy magma, from which they were projected as loose material; they must have been partially crushed, and wherever fracture occurred the glass was carried away, while where they remained unbroken the vitreous mass protected the faces of the crystal. The augite of the tufa we are describing has a great tendency to form twin-crystals as polysynthetic as those of some plagioclases. These lamellar individuals, intercalated in the principal crystal, are extremely distinct and remarkably regular; when large enough, they betray their presence by sections with reëntrant angles (see fig. 16) formed by the alternating faces of two adjacent individuals. Sometimes, too, the

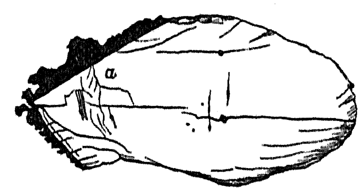


FIG. 15.—Tufa of Tristan da Cunha. Clastic grain of olivine crystal, certain outlines (a) exhibiting crystallographic contours bordered by black glass.

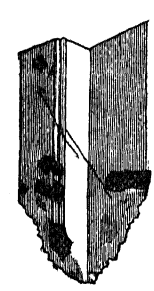


FIG. 16.—Tufa of Tristan da Cunha. Polysynthetic twinning of augite; reëntrant angles at the upper part of the section by the alternation of the faces of two adjacent individuals.

outlines of these reëntrant angles are replaced by a straight face, which restores these broken lines, as is to be seen in fig. 17, showing a polysynthetic augite from this tufa.

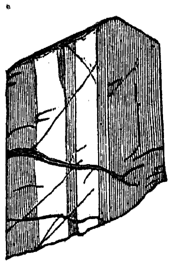


FIG. 17.—Tufa of Tristan da Cunha. Section of a polysynthetic crystal of augite with straight outline corresponding with $\bar{P}\infty$ of one individual.

In the upper, most clearly developed, part of fig. 17, we ought, considering the size of the polysynthetic lamellæ, to recognise the successive traces of the angles formed by the juxtaposition of the twinned individuals; but we find only one straight line whose direction corresponds to $\bar{P}\infty$ of one of the individuals. We often observe intercrystallisations of augite and plagioclase; sometimes the two minerals, embedded the one in the other, have their vertical axes parallel. The crystals of plagioclase, augite, olivine, and magnetite are often of somewhat large dimensions. Those of augite and plagioclase are corroded, and show the effects of the action of the base which surrounds them. In this matrix we find the same minerals, but of much smaller dimensions; the small plagioclastic crystals sometimes assume the shape of rhombic tables, often observed for the bytownite of recent eruptive rocks.

As we have just seen, the superposed rocks that form the horizontal beds all belong to the felspathic basalts, with vitreous matrix. Among the specimens which we have examined, and which, according to Mr. Buchanan's notes, are to be regarded as lavas, we find some that show certain peculiarities of structure. They are more scoriaceous, but their mineralogical composition is the same. Among the scoriaceous rocks there are some of dark-greyish colour, having their vesicles studded with zeolites; they contain crystals of augite measuring a centimetre. Under the microscope large lamellar sections of plagioclase are seen, often twinned on the Carlsbad type; two simple twinned individuals give very different extinctions, 35° for one individual and 24° for the other, so that very probably we are dealing with a section parallel at once to both P and x. In the thin sections the augite is dark green, with a yellowish tint produced by incipient alteration; apatite sometimes occurs as an inclusion in the augite; the preparations also show olivine, magnetite somewhat rarely, and scales of hematite. These various minerals stand in a ground-mass in which are gathered very minute microliths of plagioclase, augite, and magnetite, with almost no intervening matrix.

Other specimens of lava exhibit transition towards the pyroxenic andesites. These rocks are compact, like the basaltic lavas described above; their microscopic appearance is identical, only we find no olivine in the preparation; the constituent minerals are plagioclase, augite, and magnetite, with the addition of biotite in small brownish lamellæ. These small crystals are all set in a matrix formed of faintly-coloured glass.

Hornblende is rare in the lavas of Tristan, only one rock having been found to yield it. This rock closely resembles the andesitic lavas in microscopical characters;

it is slightly more schistose, less compact, and not so dark in tint. Under the microscope it is found to be composed of the following minerals of the first generation: large crystals of plagioclase, augite, and hornblende. The sections of this last species are encircled by a zone of magnetite. These sections stand out from an almost colourless glassy matrix, containing microliths of plagioclase, augite, and magnetite.

Another specimen belonging to the bedded rocks consists of a fragment taken from a layer of loose volcanic products, overlaid by a sheet of lava. From the structure of the specimen, it is evident that it is composed of two layers, indicating successive deposits. The one has the composition and texture we have recognised in all the basaltic lavas of the island; the other is an agglomeration of glassy splinters, plagioclase, augite, and magnetic iron; all these minerals are fragmentary, and the layer in question ought to be regarded as a basaltic tufa.

We have given the lithological characters of the lava-streams and tufa that constitute the greater part of the rocks cropping out on the coast; it remains to indicate the nature of the transverse dykes injected into these superposed layers. The specimens procured from these dykes look to the naked eye like compact basalts of blackish tint, giving slight indications, also, of a columnar structure. One fragment which was contiguous to the encasing rock exhibits, to a depth of about a centimetre, the black vitreous modification with brilliant lustre, well known in basaltic rocks that have been subjected to sudden cooling.

To judge from the specimens we have examined, these dykes are felspathic basalts, presenting sometimes a transition into augitic andesites. The minerals of first generation are magnetite, olivine, and plagioclase. The last-named crystals are lamellar; the extinctions, measured symmetrically on two adjacent hemitropic lamellæ, are about 36°. This felspar, therefore, approaches labradorite. The ground-mass of this rock is somewhat remarkable (see fig. 18). It is almost entirely composed of augitic microliths, which are grouped in rosettes or twinned crosswise, and sometimes planted almost perpendicularly on the plagioclastic lamellæ or between the small prisms of augite, forming a fibro-radiating aggregate. Crystals of olivine with hexagonal or rhombic contours are frequent, and they enclose a nucleus of glassy substance.

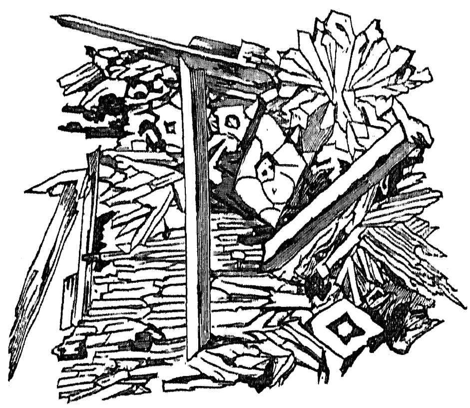


FIG. 18.—Dyke of felspathic basalt, Tristan da Cunha. Ground-mass composed of augite microliths in rosettes or planted perpendicularly on the plagioclastic lamellæ, and crystals of olivine with vitreous inclusions.

Magnetite, in more or less irregular grains, fills up the interstices between the various minerals that constitute the matrix. The other specimens from the injected dykes have the same mineralogical composition and the same texture.

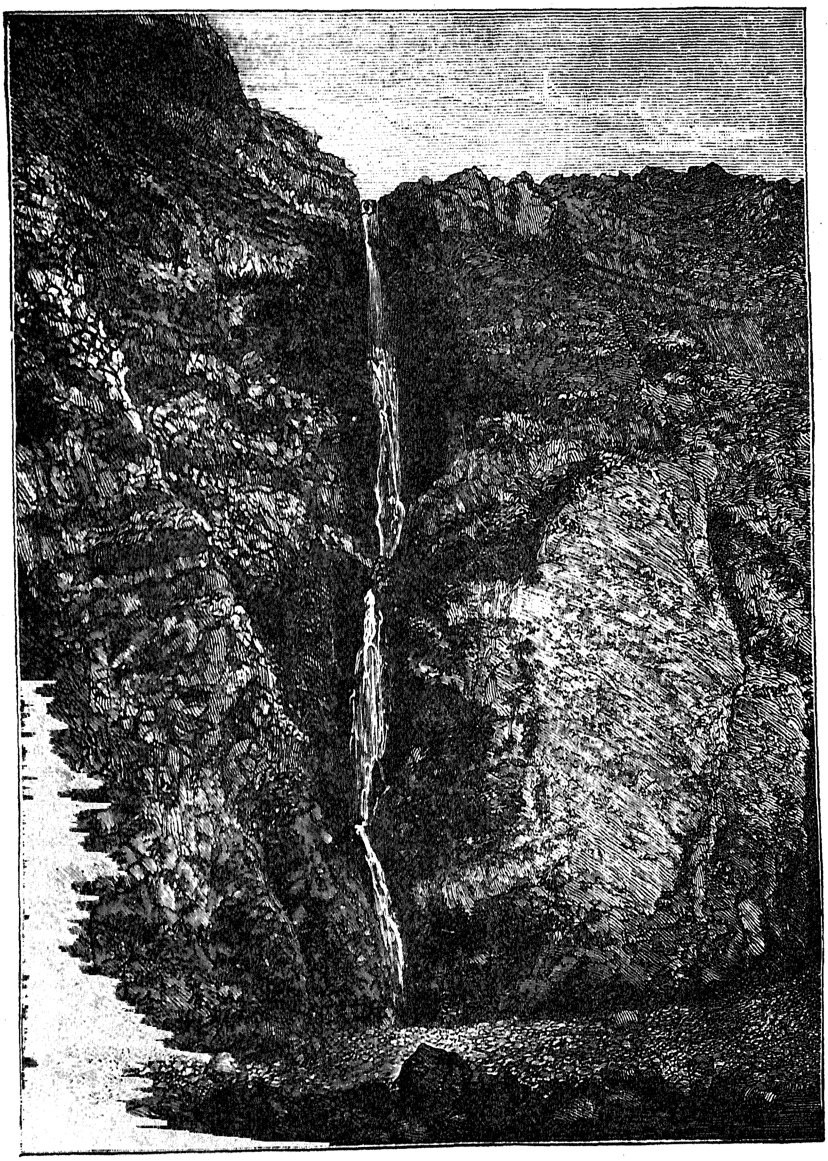
Among the specimens of rock from the Island of Tristan, there is a vitreous fragment, very compact, and with a slight reddish reflection, which the inhabitants use for striking fire. This rock when examined under the microscope is seen to have a very dark vitreous matrix; in some parts it is slightly transparent and brown. The minerals developed in it are augite and plagioclase. This latter mineral is present in lamellar sections, somewhat large at times, and sometimes riddled with vitreous inclusions; the large plagioclase crystals are even visible with the lens; we observe also much smaller lamellæ of triclinic felspar, scattered sporadically in the ground-mass. The dimensions of the crystals of augite with magnetite inclusions are the same as those of the large plagioclase crystals; their forms are well marked, and a certain number among them are twinned like those previously described in the lavas of the island. There are also to be seen in the base a great many small sections of augite, as well as some microscopical sections of olivine. This rock, which one would at first sight place alongside of obsidian, ought to be referred to the felspathic basalts; it constitutes a very vitreous variety of that type.

The soundings of the Challenger around the Island of Tristan brought up samples of the sediments that are deposited near the island. The mineral particles that occur in these deposits are exclusively of volcanic origin. The fragments that enter into their composition are microscopical fragments of the rocks which we have just described, or of the minerals that form these rocks. One dredging (18th October 1873) brought up a fragment of hard, black, massive rock, weathered on the surface; microscopical examination showed that it belonged to the basalts; it greatly resembled the rocks forming the dykes in Tristan. We find in it microliths of plagioclase elongated in a direction parallel to P/M, and giving extinctions of about 30°; and, still further, small sections of olivine and apatite. The black pigment of the ground-mass is concentrated at certain points. All the characters of this rock go to show that it came originally from the Island of Tristan. The same statement does not hold good of the fragments of pumice collected in the same dredging. The ubiquity of pumice in pelagic deposits is a well-known fact, and Mr. Murray has shown how these volcanic products may come to be deposited at points far removed from their place of origin. We are thus led to regard these fragments of pumice as in no way appertaining to the rocks of Tristan. Macroscopic examination shows the presence of sanidine in this pumice; under the microscope the same mineral is seen in splintered crystals, without either regular outlines or hemitropic striæ. Plagioclase, with the twinnings of albite and pericline, is also present.

B.—*Rocks of Inaccessible Island.*

Inaccessible belongs to the same group as Tristan da Cunha. It lies to the west of the other islands, and is a little smaller than Tristan, from the summit of which its

centre is about twenty-three miles distant.[1] Abrupt cliffs, fringed with a line of breakers girdling the island, appear at first sight to make landing impossible, but there is a narrow beach at the base of the vertical rocks. Inaccessible Island is nearly



Waterfall, Inaccessible Island (*from a Photograph*).

quadrilateral in outline, the angles being directed towards the cardinal points. The highest part of the island is towards the west, where the cliffs rise to the height of

[1] For the physical description of Inaccessible see Wyville Thomson, The Atlantic, vol. ii. p. 156; Moseley, Notes of a Naturalist etc., p. 115; *Narr. Chall. Exp.*, vol. i. p. 254. Buchanan has given geological details on this island in *Proc. Roy. Soc.*, vol. xxiv. p. 614.

1840 feet above the sea level, the average elevation of the rocky wall being about 1100 feet. A crag 1140 feet high occupies the southern angle, and a conical mound of 700 feet rises on the south-west, the two heights being separated by a V-shaped ravine, probably produced by atmospheric erosion.

The geological structure of Inaccessible is identical with that of Tristan, and the appearance of the two islands is consequently similar. The vertical cliffs present a series of good sections, which show the island to be built up of successive horizontal beds of eruptive rocks, traversed by oblique or vertical dykes. As at Tristan, the coast cliffs terminate in a plateau. Boulders, broken off by the waterfalls from the lava-beds and dykes, have collected at the base of the rocks, passing on the seaward side into a belt of rounded basaltic pebbles. The rocks dip almost vertically into the sea, and there are very few places where they can be climbed in order to reach the central plateau. Soundings of from fifty to ninety fathoms occur a few yards from the cliffs.

Sir Wyville Thomson was so struck by similarities in the physical geography of Tristan and Inaccessible as to hazard the opinion that these eruptive masses, now separated by twenty miles of water, had once been united. According to the description of the naturalists of the Challenger, the rocks of Inaccessible very closely resemble those of Tristan, and they have the same arrangement. We will first describe the rocks forming the lava sheets and the tufa.

Almost all the specimens from Inaccessible are felspathic basalts; the differences between them are chiefly in texture, and sometimes in the development of a vitreous base. A porphyritic basalt, which appears to take an important place in the structure of the island, has given rise by decomposition to a yellowish earthy substance, to be described further on. This basalt is a black scoriaceous rock containing many crystals of augite, sometimes a centimetre in length, olivine, and felspar. Felspar is the least abundant constituent, and its crystals are the smallest. Microscopic preparations show that the ground-mass in which these porphyritic crystals are embedded is formed by a yellowish or altered base, which penetrates all the fissures of the larger minerals. This ground-mass contains small augite sections, some of them star-shaped, showing penetration twins; these microliths are associated with minute plagioclase sections and with magnetite. The large porphyritic crystals of augite are zonary, and have a somewhat pale pink colour; the regular sections of olivine are a little smaller, and have been slightly altered at the edges; a yellowish zone surrounding this mineral shows that it is being decomposed into hematite. It contains numerous inclusions of magnetite, and shows traces of twinning. If there were no small crystals of plagioclase in the base this rock would be classed with limburgite, which it resembles macroscopically in several ways.

This basalt decomposes into a yellowish earthy substance, from which crystals of

augite may be easily separated. The following analysis of these crystals was made by Dr. Klement; it shows that this pyroxene is akin to chromiferous diopside.

I. 1·2557 grammes of substance dried at 110° C. and fused with sodium and potassium carbonate gave 0·6504 gramme of silica, 0·0485 of alumina, 0·0071 of chromic oxide, 0·0888 of ferric oxide, 0·2815 of lime, 0·5476 of magnesium pyrophosphate and traces of manganese.

II. 1·1195 grammes of substance treated in a sealed tube with sulphuric and hydrofluoric acids required 7·2 cubic centimetres of potassium permanganate solution to oxidise the ferrous oxide (1 c.c. = 0·005439 gramme FeO)—

Silica, SiO_2,	51·80
Alumina, Al_2O_3,	3·86
Chromic oxide, Cr_2O_3,	0·57
Ferric oxide, Fe_2O_3,	3·19
Ferrous oxide, FeO,	3·50
Manganese,	traces
Lime, CaO,	22·42
Magnesia, MgO,	15·72
	101·06

Another rock, which was labelled as a lava, and must have been poured out in sheets, closely resembles that just described. It contains rather large crystals of augite and lamellæ of plagioclase, which sometimes measure two or three millimetres, but olivine is not common. The rock is vesicular, and has a bluish grey ground-mass. Microscopic examination shows that the fine-grained paste is formed of small aggregated plagioclastic lamellæ, with augite and magnetite, but free from any vitreous constituent. Sharply crystallised olivines stand out from the ground-mass; some of them are twinned, most probably following a dome. There are also zonary crystals of augite, each of the zones extinguishing at different angles; these are twinned, following the orthopinacoid, and the twins are frequently repeated polysynthetically. The lamellæ of microporphyritic plagioclase are often twinned according to the Carlsbad, pericline, and albite laws. Sections almost perpendicular to *P*/*M*, showing very thin and sharp periclinic striæ, extinguish at angles between 35° and 39°; this felspar, therefore, approaches anorthite.

Other basaltic lavas show no porphyritic structure, the only element visible to the naked eye being lamellæ of plagioclase of three or four millimetres in size, which have lost their glassy sheen. The mass is bluish grey and scoriaceous; augite and grains of olivine may be distinguished by the lens. Under the microscope the ground-mass is seen to be devitrified by trichites, and to contain augite and magnetite microliths, as well as very slender crystals of plagioclase, sometimes assuming a stellate form. Olivine is

one of those first-generation minerals which determine the microporphyritic structure. This mineral occurs in rather large sections with sharp crystallographic outlines; sometimes the form is hexagonal; two of the sides belong to the vertical zone, and are perpendicular to the plane of the optical axes. Others form an angle nearly of 77°, these being thus traces of the face $\bar{P}\infty\,(d)$. These sections show cleavages perpendicular and parallel to the vertical axis, and a third rather indistinct cleavage parallel to *d*. This olivine has a light greenish colour, but is transformed into a red hematite-like matter along the cleavage planes and fractures, and on the edges of the sections. It may also be penetrated by a network of dendritic oxide of iron. This formation of hematite may be connected with the accumulation of grains of magnetite on the edges of the olivine. This mineral has been subjected to corrosion and dislocation, and is often enclosed in augite. The large zonary crystals of plagioclase have been deformed by mechanical strain, and exhibit undulating extinction. They are much lengthened and lamellar, being twinned according to the Carlsbad, albite, and pericline laws. Extinction takes place at a large angle, sections more or less parallel to *M* extinguishing at 43°; the plagioclase is thus to be grouped with anorthite. Augite is the third microporphyritic element, but its sections show few noteworthy peculiarities; they are feebly pleochroic, the differences in absorption being scarcely perceptible. Sometimes these sections are twinned and exhibit a zonary structure, the inner part approaching to violet in tint, while the outer layers remain almost colourless. This augite is filled with vitreous inclusions, magnetite, and sometimes patches of olivine. In the vesicles are seen groups of small acicular crystals, probably some zeolite.

Judging by the specimens at our disposal, doleritic basalts are not common in Inaccessible, only one instance of a dolerite occurring in the collection, and its characters appear most plainly when the rock is examined microscopically. To the naked eye it is scoriaceous, with large vesicles; the ground mass is bluish grey, speckled with irregular white spots of altered felspar. The microscope shows that all the minerals are approximately of equal size. In this rock also olivine has crystallised first, and it exhibits several of the peculiarities already described, being coloured yellowish by alteration, and often surrounded by a zone of delessite. Lamellæ of felspar, somewhat drawn out, surround grains of augite. Sometimes these two minerals are oriented with their axes parallel, at other times they cross each other at various angles; both belong to a secondary stage of consolidation.

Another rock, resembling in structure the dolerite just described, differs from it by the absence of olivine and the presence of a base, in which the minerals giving the rock a doleritic structure are embedded. The base, which is devitrified by trichites, surrounds crystals of augite, appearing to play an unimportant part, and large zonary sections of plagioclase. These felspar sections are more basic at the centre than in the

outer zones. Sections of the zone $P:k$ give symmetrical extinctions of 28°–27° for the inner, and of 21°–17° for the external zones. The central parts thus approach anorthite, while the outside comes nearer to labradorite. Notwithstanding the absence of olivine in the microscopical preparations, this rock cannot be classed with the augite andesites, and its structure presents fewer resemblances to that type than to the dolerites.

We may note in passing some slightly vesicular rocks, the ground-mass of which is close-grained, and contains no macroscopic minerals except a few whitish grains of altered felspar. The specimens resemble ordinary basalt in every respect, and show no microscopic features meriting special attention.

Related to these rocks there are some vitreous masses altered into palagonite. They are scoriaceous like pumice, and are coloured yellowish by limonite, but do not show well the resinoid aspect of palagonitic rock. They contain small heterogeneous fragments, indicating the tufaceous origin of the deposit. Under the microscope this substance shows, between crossed nicols, in certain parts of the preparation, phenomena of polarisation like those of altered sideromelane; the vitreous mass is, however, isotropic. The base contains numerous small crystals of augite, which are sometimes capillary and of a green or brown tint. Plagioclase microliths are neither abundant nor well formed; they are often hollowed out on both extremities, and are usually present as skeleton crystals. Olivine is rare or altogether absent. Some patches seem to be made up of heterogeneous fragments; these lapilli are characterised by an obvious difference in the texture and by their mineralogical composition, as they are formed of rather large crystals of plagioclase mixed with grains of augite. The vesicles scattered through the rock contain no zeolites, remaining vacant in the centre although their walls are lined with a light transparent green layer of a secondary mineral.

Having dealt with the lavas and tufa of the island, we have now to describe the transversal dykes. The rocks forming these dykes are generally massive or finely alveolar. The porphyritic basalt with large augite crystals, described above, is traversed by a vein composed of a compact, bluish grey, slightly vesicular mass, containing macroscopic crystals of augite and olivine. This basalt when examined microscopically presents a microporphyritic appearance, produced by rather large zonary crystals of augite and olivine. The ground-mass is an aggregate of minute crystals of three minerals, plagioclase, augite, and magnetite, without interposition of any base. Another dyke, resembling the first in colour and microscopic structure, differs from it in being perfectly compact. Here also augite and olivine can be seen by the naked eye, but under the microscope the ground-mass appears composed of minute plagioclase and augite crystals, and contains a little vitreous matter. Large

sections of augite and olivine stand out from the paste; the former are zonary and pleochroic:—

γ >	β >	α
pink.	yellowish pink.	yellowish green.

As at Tristan, some of the dykes of Inacessible show the alteration well known in massive basalt when suddenly cooled: at the contact with the encasing rock it is altered into a brilliant black vitreous coating a centimetre thick. This glassy modification affords a beautiful example of devitrification by trichites of ilmenite, and shows a tendency to perlitic structure. The glass itself is yellowish, and depolarises light at certain points, usually near the edge of the small crystals or in the outer zone of the vesicles, a phenomenon due to molecular tension. Small skeleton crystals of plagioclase and augite microliths are abundant, but black dendritic structures predominate, resembling those described by Zirkel in tachylite.

The following analysis of the black vitreous coating of one of these dykes produced at the contact of the encasing rock has been made by Dr. Klement:—

I. 1·0648 grammes of substance, dried at 110° C., and fused by Sipöcz's method with alkaline carbonates, gave 0·0071 gramme of water, 0·5120 of silica, 0·2028 of alumina, 0·1028 of ferric oxide, 0·1003 of lime, and 0·1035 of magnesium pyrophosphate.

II. 1·1578 grammes of substance treated with hydrofluoric acid gave 0·1621 gramme of sodium and potassium chlorides and 0·1718 gramme of potassium chloroplatinate.

III. 1·0733 grammes of substance treated in a sealed tube with hydrofluoric and sulphuric acid required 11·1 c.c. of potassium permanganate solution (1 c.c. = 0·005405 gramme FeO) to oxidise the ferrous oxide.

IV. 1·6478 grammes of substance treated with hydrofluoric acid gave 0·0722 gramme of titanic acid.

Silica, SiO_2,	48·09
Titanic acid, TiO_2,	4·38
Alumina, Al_2O_3,	19·05
Ferric oxide, Fe_2O_3,	3·44
Ferrous oxide, FeO,	5·59
Manganese,	traces
Lime, CaO,	9·42
Magnesia, MgO,	3·50
Soda, Na_2O,	5·06
Potash, K_2O,	2·88
Water, H_2O,	0·67
Total,	102·08

The non-altered basaltic mass adjacent to these vitreous black bands is filled with arborescent trichites of ilmenite, which appear slightly brownish in transmitted light;

most of them are grouped round a perfectly colourless prismatic crystal of plagioclase, to which they are attached. Many crystals of magnetite and ilmenite are to be seen, and plagioclase is more abundant than in the vitreous zone, although the crystalline form is embryonic; augite occurs in rosettes of little crystals. The shining black part of the vein is perfectly compact, but the internal portion is slightly vesicular, the pores being lined with a transparent coating of green secondary matter which also penetrates the microscopic fissures of the rock. The whole mass of the dyke must have been cooled rapidly. Olivine is scarcely to be found in this rock.

All the rocks from Inaccessible dealt with so far conform more or less strictly to the basaltic type. A rounded pebble picked up on the shore is a bronzite and biotite andesite. This specimen shows that eruptive masses different in composition from those of the coast must exist in the interior of the island. The appearance of the pebble shows at once that it differs from the ordinary rocks such as those described above. It is much lighter in colour, being whitish grey. The texture is fine-grained, the fracture nearly plane, and no constituent minerals appear to the naked eye. Under the microscope a colourless ground-mass is seen, formed chiefly of curved and twisted crystals of plagioclase of indefinite outline, and all matted together. Mixed with these there are some violet-coloured augite microliths, with irregular outlines, but evidently of the same stage of consolidation. Some scales of biotite also appear. All these minerals are of approximately uniform size, and have crystallised simultaneously. Small yellowish crystals appear in the paste as isolated short prisms, with flattened summits, and worn on the angles. Sometimes these occur as irregular grains with fractures, but they are too minute to permit their forms to be definitely ascertained. These small sections give straight extinction, and so far as they could be examined by convergent light it has been proved that the plane of the optical axes is parallel to the brachypinacoid. These crystals ought to be considered as bronzite, and the rock as a bronzite andesite.

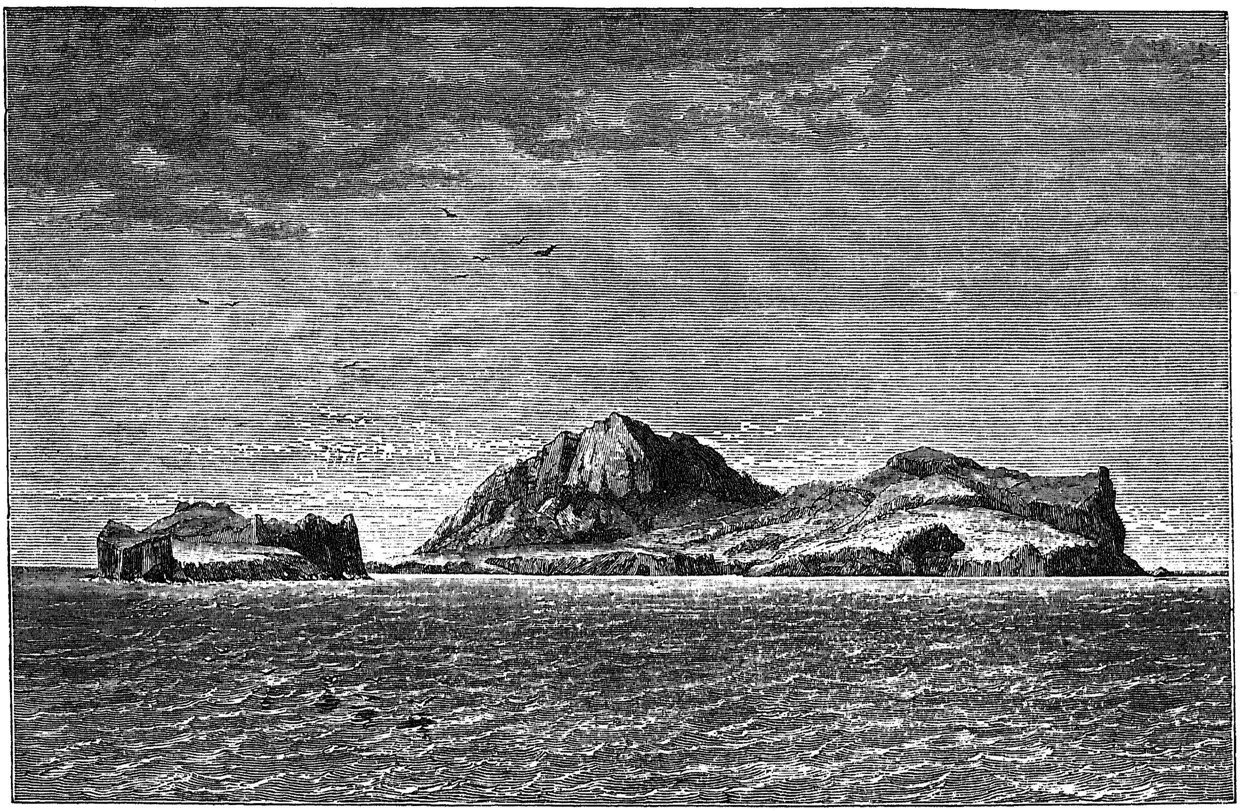
C.—*Rocks of Nightingale Island.*

Nightingale is the smallest island of the Tristan da Cunha group, lying towards the south. It is surrounded by rocks, amongst which are two islets measuring one-half by one-sixth of a mile. One of these, Middle Island, 150 feet high, with an undulating summit, is situated in lat. 37° 25′ 50″ S., and long. 12° 29′ 45″ W. The second islet, which also lies to the north of Nightingale, is Stoltenkoff Island, and has a height of 325 feet. Nightingale Island is a mile long from east to west, and about three-quarters of a mile broad.[1] A channel ten miles wide, and over 465 fathoms deep,

[1] For the natural history of this little group, see Thomson, The Atlantic, vol. i. p. 185 (with a map); Moseley, Notes of a Naturalist on the Challenger, p. 126; *Narr. Chall. Exp.*, vol. i., pp. 262 *et seq.* For its geology, see Buchanan, *Proc. Roy. Soc.*, vol. xxiv. pp. 614, 615.

separates Nightingale from Inaccessible, while depths beyond 1000 fathoms occur in some places between Nightingale and Tristan.

On account of the weather and the difficulty of gaining access to the interior of Nightingale, the Challenger naturalists had to limit their geological collections to the rocks which cropped out near the shore. Nightingale differs greatly in appearance from the other islands of the group, being more varied in outline and surrounded by cliffs only thirty or forty feet high, and often less. The southern part of the island is more

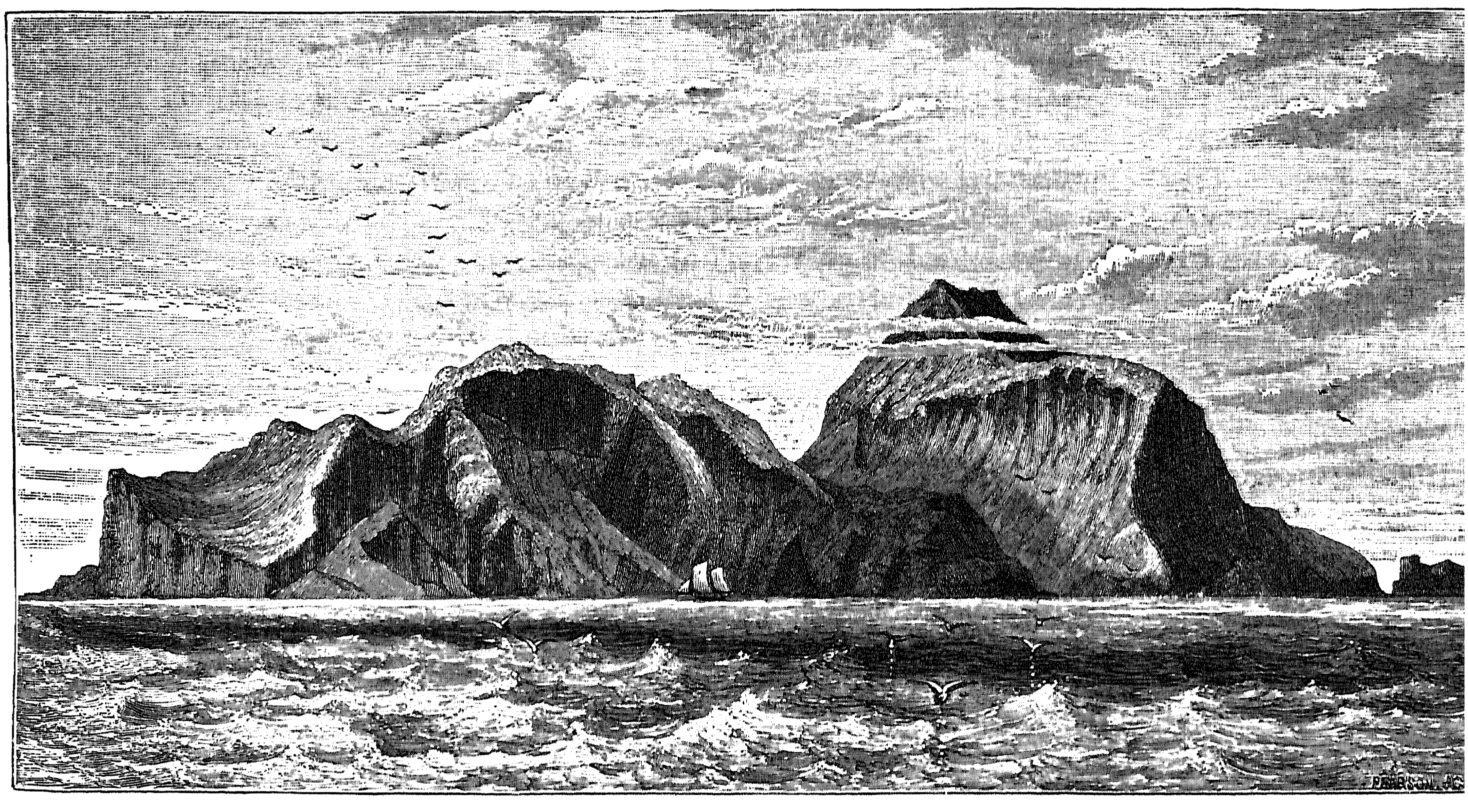


Nightingale Island, from the North.

picturesque, the ground rising by successive crests to a peak 1105 feet high, one side of which is almost vertical for half its height. Mr. Buchanan was unable to ascend this hill, but he describes the rock as being greyish in colour, and of a sub-columnar structure. The rest of Nightingale is undulating, and the rocks, except at a few isolated points, are covered with verdure. No traces of recent volcanic activity are to be seen. The rocks of the coast are chiefly a conglomerate or breccia of doleritic fragments embedded in a whitish felspathic mass. Here and there the conglomerate is surrounded by beds of volcanic rock probably of more ancient origin. Marine erosion has hollowed the cliffs girdling the island into innumerable caves, formerly the refuge of seals, which

have now been driven elsewhere by indiscriminate slaughter. The fact that the caves are situated a little above sea-level, proves that the island has been recently elevated. A raised beach on the top of the cliffs confirms this supposition.[1]

The stratum of volcanic conglomerate at the base of the shore cliffs is, so far as can be determined from the specimens examined, a phonolitic tufa. The bluish grey rock is speckled with white kaolinised patches; the ground-mass is waxy and considerably altered, and is impregnated with limonite in some places. Under the microscope, the



Nightingale Island, from the South.

mass is composed of minute sections of nepheline, usually as grains, but frequently in the form of parallelograms or hexagons. The nature of this mineral is also proved by the microchemical reaction of sodium. These crystals are arranged in line, and like the other mineral constituents show well-marked fluidal structure. Microliths of augite are associated with the nepheline; these are brownish, show no evident pleochroism, and extinguish at angles large enough to prevent confusion with hornblende. Small sections of sanidine are also present. Several minerals give the rock a microporphyritic appearance, plagioclase being the most important. The felspar crystals are often twinned

[1] The above is a summary of Mr. Buchanan's geological observations at Nightingale (*loc. cit.*, pp. 614, 615)

according to the Carlsbad law, and at the same time traversed by polysynthetic lamellæ after the albite law. Hornblende occurs associated with the plagioclase; the crystals of both species are deeply hollowed and corroded. Rather large brownish hornblende sections are seen surrounded by a zone composed of little green grains of augite with granules of magnetite, biotite, and titanite. In this phonolitic mass are embedded heterogeneous clastic fragments, which prove the tufaceous origin of the rocks forming almost the entire explored portion of the island.

Dr. Klement has obtained the following results from an analysis of this tufa:—

I. 1·0676 grammes of substance dried at 110° C. and fused with alkaline carbonates, by Sipöcz's method, gave 0·0116 gramme of water, 0·6102 of silica, 0·0285 of titanic acid, 0·2142 of alumina, 0·0535 of ferric oxide, 0·0421 of lime, and 0·0459 of magnesium pyrophosphate.

II. 1·0339 grammes of substance treated with hydrofluoric acid gave 0·1875 gramme of sodium and potassium chlorides, and 0·241 of potassium chloroplatinate.

III. 1·1143 grammes of substance treated in a sealed tube with hydrofluoric and sulphuric acids required 4·0 c.c. of potassium permanganate solution (1 c.c. = 0·005439 gramme FeO) to oxidise the ferrous oxide.

Silica, SiO_2,	57·16
Titanic acid, TiO_2,	2·67
Alumina, Al_2O_3,	20·06
Ferric oxide, Fe_2O_3,	2·84
Ferrous oxide, FeO,	1·95
Manganese,	traces
Lime, CaO,	4·41
Magnesia, MgO,	1·55
Soda, Na_2O,	5·84
Potash, K_2O,	4·52
Water, H_2O,	1·09
	102·09

Some specimens collected by Mr. Buchanan in a gully prove the presence of eruptive masses of the andesite type at Nightingale. The rock in question is black and massive, with a plane fracture and rather schistose. Crystals of felspar, about three or four millimetres in diameter, and of hornblende of nearly equal dimensions, shine out from the mass. Microscopically there is a glassy ground-mass containing porphyritic minerals of the first generation. Plagioclase is the most noticeable, and its sections are remarkable in that instead of the usual lengthening along the edge P/M, they show a great extension following yM; in fact many sections take the form of disymmetric hexagons (sections nearly parallel to M) in which the shortest sides correspond to the edge P/M; this is confirmed by examining the best-marked lines of

cleavage which run parallel to the short sides of the hexagon. The trace of T/M is indicated by its parallelism with the prismatic cleavage, which is rather less distinct than that just spoken of. It frequently happens that all the outlines of these sections are not equally distinct, or only appear clearly for part of the section, the rest being terminated by a fracture nearly parallel to the prism. These hexagonal sections show that the plagioclase is zonary, and that the extinction is negative. The angular value is greater for the centre than for the outer zone, being from 14° to 10° for the former, and 10° to 3° for the latter. This felspar is thus probably composed of mixtures intermediate between oligoclase and labradorite. Sections following M show the lamellæ after the pericline law almost parallel to the edge P/M; this, according to M. Schuster, is the case for plagioclases approaching andesine. These sections are full of vitreous inclusions, which have no definite arrangement, but are specially numerous near the centre of the crystal, and sometimes follow the external outline and planes of cohesion. The included vitreous matter, which also occurs in the large crystals of augite and hornblende, is of a less deep brown colour, and sometimes contains microliths similar to those of the ground-mass. This fact, taken together with the corrosion of the crystals containing these inclusions, proves that they have been penetrated by the magma in which they were immersed.

Hornblende plays an important part in this rock. Its crystals are prismatic, much elongated, corroded, and fragmentary; this mineral is generally decomposed, its cleavages being as a rule indistinct. Magnetite often encircles the sections as an external zone; probably these small opaque crystals were attracted around the hornblende even before alteration commenced. Inclusions of apatite sometimes occur. The pleochroism is—

α	$<$	β	$<$	γ
yellow.		brown.		dark brown.

Augite of the first generation appears in corroded crystals of the ordinary form and pleochroic—β, bright yellow; α and γ, green. The polarisation colours are whitish yellow, and the tints are brilliant in sections more or less perpendicular to the vertical axes. The mineral is often twinned following the orthopinacoid. It is zonary, and gives larger extinctions for the central parts than for the peripheral layers (34° for the former, 30° for the latter). Patches of augite formed of agglomerated grains are also sometimes seen. Biotite is not common in the rock, but small crystals of magnetic iron are extremely abundant.

The ground-mass embedding the minerals described above is composed of an almost colourless base containing minute lamellæ of plagioclase extinguishing at very small angles, and nearly colourless augite microliths distinguished sharply from the felspar by their more brilliant polarisation colours.

Some specimens of rock forming the floor of "Bromley's Cave"—one of the cliff-

caverns on the coast examined by the Challenger naturalists—were collected. This rock, an augite-andesite, is black and massive like a compact basalt; the fracture is plane. No constituent minerals can be detected either by the naked eye or with a lens, but the microscope shows some microporphyritic sections. Amongst these there are a very few plagioclastic lamellæ giving large extinctions, and some sections which, from the absence of polysynthetic twins may be referred to sanidine; the latter are traversed by two cleavages at right angles, and give straight extinction. The augite of this rock is of a light violet colour, its outlines are irregular, and large crystals seldom occur. Corroded hornblende sections are also found as microporphyritic elements, sometimes twinned according to the ordinary law; they show the pleochroism —α, yellow; β, brown; γ, brown. This mineral is sometimes quite decomposed, being invaded by augite microliths and magnetite. The ground-mass of the rock resembles that of basalt in some respects; it contains numerous plagioclastic lamellæ and microliths of several minerals. Those of augite are almost always twinned, the sections appearing to be divided in two longitudinally; the summit is terminated by a low dome, and transverse sections appear as irregular, slightly-coloured grains. Hornblende is present in small pleochroic fibrous prisms which might be taken for biotite, but the extinction is oblique. The rock has been slightly altered with formation of delessite.

An intrusive vein of amphibolic andesite crops out on the floor of Bromley's Cave. It is a black rock with a plane, more or less schistoid, fracture. A very few drawn out vesicles are to be seen, and to the naked eye only some fine needles of hornblende appear, while the lens shows a mass composed of crystalline grains. Microscopical preparations show that microporphyritic crystals of plagioclase, hornblende, augite, and magnetite are embedded in the ground-mass. Under a low power the paste appears brownish and homogeneous, but when more highly magnified it is seen to be made up of an aggregation of plagioclase, augite, and hornblende microliths, the last named being present in greatest number. The crystals of the first generation which produce microporphyritic structure are generally corroded.

Large sections of plagioclase are sometimes lengthened following the edge P/M, sometimes flattened parallel to M; this mineral also occurs as grains. The felspar is related to anorthite, the maximum angle of extinction in the zone $P:k$ being about 39°; two adjacent hemitropic lamellæ gave a maximum extinction of 31°. The structure is usually homogeneous, but when the sections are zonary the centre is more basic than the outer layers. There is nothing remarkable about the large ill-defined sections of augite which are identified by their pale greenish colour, characteristic cleavages, crystallographic outlines, and the angles of extinction. Hornblende is more important, and often appears in irregular corroded grains, although the form is sometimes fusiform, or that of a much-lengthened prism. The sections are almost always twinned according

to the ordinary law, and this twinning is shown in the most slender crystals, where it appears in the sections as two extremely thin lamellæ that give the mineral a fibrous aspect. The colour is brown, and the pleochroism is very well marked—

γ	>	β	>	α
deep brown.		yellowish brown.		pale yellow.

These crystals extinguish at a less angle than is usual for hornblende. Magnetite occurs in the preparations as irregular grains or sections of octohedra.

The ground-mass is composed of crystals of secondary consolidation showing distinct fluidal structure. When examined under very high powers the paste is seen to contain sections of plagioclase usually much lengthened following the edge P/M, and twinned according to the albite law; the little crystals are often grouped in rosettes. A series of extinctions measured from the trace of M gave values between 16° and 32°, the polysynthetic lamellæ giving for one side 20°, for the other 30°, 26°–30°, 13°–16°, 36°–44°. These crystals accordingly differ little in composition from the felspar of first generation. Microliths of augite are also present in the form of greatly lengthened prisms, sometimes broken in several pieces and of a very pale green colour; 40° is the maximum angle of extinction. The part played by hornblende in the ground-mass ought to be noted here. From the minute dimensions and brownish colour of its crystals this mineral might be taken for a glassy base devitrified by microliths, and interposed between the larger sections of plagioclase and augite. A high power, however, brings out the individual crystals as small, fibrous, brownish prisms, sometimes lying in parallel lines or grouped in bundles, sometimes interwinned so as to form a network. They often show distinct pleochroism and extinguish at small angles, while their fibrous structure and elongated form complete their analogy with the larger individuals of the same species. Magnetite appears in very definite sections of octahedra. A network of trichites is occasionally observed closely resembling that of hornblende crystals referred to above; the trichites may perhaps be magnetite, but more probably they are altered hornblende.

All the rocks seen on the coast of Middle Island, which lies a little to the north of Nightingale, are composed of the tufaceous mass now to be described, and according to Mr. Buchanan's observations the entire islet is probably an accumulation of the same formation. The rock is a yellowish, pumiceous, almost earthy, substance, enclosing lapilli and very distinct hornblende crystals. Microscopic examination shows that it is formed of cemented fragments. The most important rock occurring in this tufa will be briefly described. Under the microscope it shows a very compact groundmass surrounding fragmentary microporphyritic crystals of hornblende, plagioclase, sanidine, and augite, the splinters of the last-named mineral being smaller than those

of the others. The largest crystals of plagioclase are corroded; they are sometimes zonary, and show the twins of albite and pericline; from its extinctions the felspar may be classed as labradorite. Sanidine, which is frequently associated with the former, is distinguished by the absence of hemitropic lamellæ, and by the very small angles of extinction in almost all the sections examined. These are sometimes twinned according to the Carlsbad law, and in one case that of Baveno was observed; the extinction is almost always undulating.

The grains of augite are corroded like the felspar, and when little altered their colour is green without pleochroism; their structure is zonary; the centre, which is darker in tint, extinguishes at 36°, the outer zone only at about 45°. Augite is sometimes entangled in brown hornblende sections, the two uniting with parallel axes, and it often forms irregular inclusions in the hornblende along with apatite. Hornblende is a much more important constituent than augite; its sections, which are always brown and strongly pleochroic, are surrounded by an altered zone where magnetite has accumulated. The only other constituent of any size appears in irregular, dirty-brown patches, scarcely transparent, and standing out in marked relief; it is evidently titanite, and is sometimes transformed into calcite.

The paste enclosing the minerals mentioned above is formed of a network of nearly colourless microliths showing fluidal structure. Amongst these may be seen very minute sections of sanidine with indistinct outlines fibrous in appearance, and with straight extinction; they exhibit the Carlsbad twinning, and in ordinary light appear almost as a homogeneous mass. Equally minute microliths of augite occur amongst the foregoing, and may be distinguished by their colour, the chromatic polarisation, and the angles of extinction. Magnetite is present in the ground-mass, but to a very unimportant extent. Finally, there are small, clear, colourless splinters of quartz. The preparation is traversed by veins in which ferric oxide has been deposited.

Thin slices of this tufa show the true characters of a microscopic breccia. Alongside the fragments of the trachytic rock just described, and the splinters of which play the most important part in this tufa, there are small lapilli of an entirely different lithological nature, rich in plagioclase and similar to basalt. Other fragments of rock related to vitreous masses of the same family are frequently changed into palagonite.

VII.—ROCKS OF THE FALKLAND ISLANDS.

A. *Rocks of the "Rivers of Stones."*

The Falkland Islands are connected by their geological character with the American Continent, thus presenting a marked contrast to the oceanic islands of the Atlantic, most of which are formed exclusively of volcanic rocks. The Falklands, on the contrary, are made up of sedimentary strata—schists, sandstones, and quartzite of Silurian and Devonian age—and archæan rocks. We shall here limit ourselves to the consideration of those remarkable "stone rivers" which form one of the most interesting features of these islands, and we propose to describe the lithological nature of some of the rocks of these "streams." Both Darwin and Wyville Thomson examined them with close attention, and described them. Combining their descriptions,[1] we may obtain an idea of the origin of these stony accumulations.

At the east end of the principal island in the Falkland group the valleys present a most striking appearance, being filled with masses of pale grey rocks, which glitter in the sun, and form tracks of from a few hundred to more than a thousand metres in breadth. From a little distance the effect is that of a gigantic glacier, descending from the neighbouring heights and gradually increasing in volume, as if it were fed by lateral streams up to the point where the main "river" reaches the coast. The stones, which vary in size from 30 centimetres to 7 metres, are not piled up irregularly, but extend in great level beds varying from 100 to 1900 metres in width. Thomson showed that the width of the stream is always in relation to that of the shelves of rock which crown the hills. Deposits of peat are constantly encroaching on the flows, and even form islands, when the fragments are near enough to afford a basis. Immense masses of rock on the hills seem to have been stopped in their course, and fragments, bending over like arches, are piled upon each other like the ruins of an ancient cathedral.

All those who have visited the Falklands agree in saying that the stones in question are not water-borne, but are angular, like the fragments of a breccia, and piled up irregularly one above another. They are not decomposed, except to such an extent as might be due to ordinary atmospheric agencies; the angles are generally worn, with a shining, slightly-polished surface. A thin coating of whitish lichen covers the stones, giving them quite the appearance of ice from a little distance. The thickness of the layer of stones is not easily determined, but the sound of running water may be heard evidently a few feet beneath the surface. At the mouth of the valley the sec-

[1] Darwin, Voyage of a Naturalist; Thomson, The Atlantic, vol. ii., p. 216. See also Narr. Chall. Exp., vol. i., p. 892.

tion of the mass, as shown on the shore, exhibits an enormous accumulation of stones, and the river flows out from beneath an archway of piled-up blocks. As we have said, the interstices of the heaps are carpeted with moss.

The inhabitants view these "stone-rivers" as one of the marvels of their island, and explain their formation by the most improbable hypotheses. Darwin seems to have accounted for them by great earthquakes in the region, but does not consider this a sufficient interpretation. Thomson suggests another explanation. The blocks of quartzite filling the valleys may come from the shelves of rock which appear on the surrounding hills (Darwin remarked that they might come laterally from the nearer slopes as well), and these piled-up blocks certainly show great lithological analogies with the higher beds. The difficulty of the problem comes in when we try to explain how the stones should descend in a close mass along a valley, the slope of which, according to Darwin, is not steep enough to hinder the passage of a coach. The slope in fact does not exceed 6° or 8°; usually it is only 2° or 3°, and it is never great enough to allow the stones to roll, or even slide, down. According to Thomson, the quartzite shelves of the hill-tops do not all resist disintegration equally, the softer parts weather into sand, and the harder, being left without support, break off into irregular blocks. This explanation is equally applicable to the crystalline rocks, the presence of which we are about to show amongst the débris. When the fragments break off vegetation rapidly covers them up, and many of the little mossy heaps are only stones covered by a thin layer of vegetation. Once enclosed in this mass they are, as it were, pushed over the slope. We may mention, amongst other causes that act as well as gravitation, the expansion and contraction of the moss as it takes up more or less water. The dilatation of the moss moves the blocks, and the superficial layer of stones is in some degree drawn towards the declivity. Rain washes off the sandy débris; this erosion prepares the way for the larger blocks, while on the other hand the adjacent vegetable matter decomposes and is washed away. It is to the slow removal of vegetable and mineral matter, and to the movement of the superficial layers—of which Thomson gave numerous examples observed by him in Scotland — that he attributes the accumulation of stones in the valleys.

Neither Thomson nor Darwin have called in ice-action as a means of transport, although it has been alleged that the Falkland Islands were covered by glaciers at an epoch not very far removed from our own. No certain proofs of glaciation are to be seen in the islands, and the stones of these streams bear no marks of glacial striæ. Only a detailed study of local conditions would enable us to say whether Thomson's theory gives an adequate explanation of all the facts. None the less is it true that this theory seems preferable by its simplicity to that which Darwin demanded, when he wrote, forty years ago, on the subject of

"stone rivers:"—"The progress of knowledge will probably some day give a simple explanation of this phenomenon, as it already has of the so long thought inexplicable transport of the erratic boulders which are strewed over the plains of Europe."[1]

The specimens collected by Thomson show lithological characters of some interest. One of these blocks is in the form of a quadratic prism, measuring about 40 centimetres by 10; the fracture is regular and polyhedric; the edges hardly show a trace of weathering, but the surface is covered by a less coherent layer of slight thickness. Beneath this thin altered surface the rock remains remarkably fresh. To the naked eye it appears to possess a granitoid structure with grains of medium size; with the lens a plagioclastic felspar can be seen, associated with a black mineral of the amphibolic or pyroxenic group. This rock belongs to the type occurring in the eruptive masses often embedded or injected amongst palæozoic strata, such as those of the Falkland Islands. Microscopic examination shows that the fragment in question must be classed as a diabase, and it also reveals that the rock possesses peculiarities of some interest, and of a kind to which the attention of lithologists is specially directed. This diabase is composed of plagioclase, augite, hornblende, biotite, and magnetite. Of all these minerals, that which at present plays the most important part is unquestionably hornblende; but this constituent is of secondary origin, and can only take a subordinate place in classifying the rock lithologically. The sections of felspar are remarkable on account of the very great number of fine plagioclastic striæ which they present. In exceptional cases only the Carlsbad twin is apparent, but in others the section shows, at the same time, lamellæ twinned according to the albite and pericline laws. These plagioclase sections do not present definite crystallographic outlines, but microscopic examination shows that they are generally elongated following on the edge P/M. It is somewhat rare to find a section parallel to M which would suffice to determine the sign and the angle of extinction. This was possible only in one case: a section presenting two cleavages, parallel to P and to T, crossing at an angle of more than 60°, gave a negative extinction of about 30°. This observation shows that the plagioclase in question approaches closely to a mixture analogous to that of bytownite. These sections of plagioclase are remarkably clear, and the phenomena of chromatic polarisation are sharp and brilliant; the decomposition, so often found in the felspars of granitoid rocks, has, as yet, only affected the plagioclase lightly. This mineral has been subjected to mechanical deformation; some of the lamellæ are laminated, showing an undulating extinction; they are strained, curved, and split up into numerous slices.

The augite of this rock presents some noteworthy features. Like the felspar it has no definite crystallographic outline. In the sections perpendicular to the axis c a net-

[1] Darwin, Journal of Researches, 1879, pp. 198, 199.

work of cleavages appears, crossing at angles of about 87°; the extinction on the face $\infty R \infty$ is more than 35°. The position of the optic axis being in the plane of symmetry, this mineral cannot be mistaken for a rhombic pyroxene; while, if the phenomena of pleochroism only were to be taken into account, there would be no hesitation in viewing these sections as allied to hypersthene, all the more because, like the latter mineral, they have a certain fibrous structure. It is very probable that this monoclinic pyroxene has often been confounded with hypersthene, but in the present case, the angle of extinction, and the phenomena in convergent light, make the determination as augite quite certain. The intense pleochroism is—

$$\underset{\text{reddish.}}{\beta} \quad > \quad \underset{\text{sea-green.}}{\gamma = a}$$

Hornblende in large greenish sections is much more widely diffused through the rock than augite, and it is only formed at the expense of the latter. In examining more minutely the relations connecting these two minerals, we observe phenomena of alteration and pseudomorphism, more magnificent examples of which than those of the Falkland Islands it would be hard to find. Augite grains can rarely be seen without a surrounding zone of greenish amphibolic matter. Decomposition commences in the microscopic fissures which furrow the surface of the augite; these become covered with a yellowish coating, making them clearly visible. If the optical properties were not taken into account, one might confound the augite, altered in this way and surrounded by the secondary product, with some sections of decomposed olivine. The colour and relief are the same, and the roughened surface and products of alteration present the same microscopic appearances in the two minerals. At a more advanced stage of decomposition the fissures appear wider, the secondary product spreads out, sometimes entirely surrounding a nucleus of nearly unaltered augite. The mineral formed in this way at the expense of the augite passes from its yellowish colour to green, takes on a finely fibrous texture at the place of contact with augite, becomes filled with opaque, blackish, ferruginous grains, and unites laterally with patches of clearly characterised hornblende. These, as we have said, always surround a fragment of augite, which remains as a nucleus in the middle of the hornblende.

The hornblende appears in large yellowish brown sections, with the optical characters and cleavage of this species, but never surrounded by crystallographic contours. The large amphibolic patches are moulded on the neighbouring minerals, and do not present the more or less prismatic form which augite preserves in spite of the granular texture of the rock. In a word, the characters of the hornblende mark it out as having been formed after all the other minerals in the rock, and its relation to augite shows that it has developed from the latter. We have thus a perfectly clear case of amphibolisation of pyroxene. It is interesting, besides, to note that

although no uralitisation can be strictly said to be observed, there exists, none the less, an orientation of the hornblende upon the augite nucleus. In fact, it is noticeable that a section of hornblende enclosing several nuclei of augite differently oriented (which could not therefore be parts of one individual) is a unique crystalloid. The cleavages are common, and so are the optical properties for each point of the section. It is thus possible to follow one of the crystalloids of hornblende a long distance from the augite nuclei which gave rise to it. The pleochroism of this hornblende is—

γ	$>$	$\beta=\alpha$
yellowish brown.		yellowish.

Biotite must also be mentioned as a constituent mineral of the rock. It is often enclosed in hornblende, and may be considered as a secondary product. Rather large sections of magnetite also occur. The grains of magnetite are also surrounded by a very narrow greenish zone of hornblende, as if the matter which gave origin to the latter had permeated the entire rock.

From the foregoing description it appears that some of the rocks from the "stone rivers" of the Falkland Islands are amphibolised diabases, of which they present a very remarkable type.

B.—*Notes on some other Rocks from the Falkland Islands.*

The following description relates to other crystalline or clastic rocks collected at the Falkland Islands. One of the most remarkable displays large scales of hornblende, which may measure as much as a centimetre, and between them grains of felspar and quartz occur. In structure and mineralogical composition it is a diorite. It contains large patches of felspar, which appear under the microscope as sections of irregular outline. In some cases no trace of twinning is perceptible, and then the felspar resembles orthoclase; but other examples, where decomposition has also reached a more or less advanced stage, show polysynthetic lamellæ, although usually not many. This characteristic would serve to class the felspar with albite; it is always difficult to determine the magnitude of the angle of extinction, on account of the small number of sections presenting hemitropic lamellæ, still, by measuring the double angle, values of about 6° to 10° were found. These large felspar patches are altered into kaolin, and penetrated by rows of epidote grains along the lines of cleavage. The hornblende, the large crystals of which are irregular in outline, shows the characteristic extinctions of this species. The pleochroism is—

γ	$>$	β	$>$	α
yellowish brown		dirty green		yellowish

Black mica occurs as inclusions in the hornblende, and grains of epidote also appear

in the interior of these sections. Titanite presents whitish grey sections; these are very sharp rhomboids with traces of a cleavage parallel to two sides of the figure. These cleavage lines should be parallel to the face r ($\rlap{\,\backslash}P\,\infty$) or l (∞P); the two other sides may be, in the first case, P ($0P$), in the second y ($\rlap{-}P\,\infty$). There are also large sections of magnetite often surrounded by a slight zone of chloritic matter, which also penetrates to the interior of the hornblende.

A specimen, which may be viewed as related to the preceding rock, is essentially composed of pyroxene and hornblende. It is granular in texture, with rather large grains, and shows biotite as an accessory element. In spite of the analogy with the diorite just described, there is no felspar in the specimen in hand, and it may be viewed as resulting from a more basic concretion such as often occurs in the ancient massive rocks. Hornblende exhibits the same characteristics as in the preceding rock, but is intercalated amongst the minerals; at other times it is enclosed in augite, and oriented like the latter. The crystals of augite generally show a better preservation of the crystalline form than the hornblende, and have more or less prismatic outlines in the sections, contrasting with the more irregular appearance of the amphibole. This mineral appears to be secondary, resulting from the decomposition of augite. It contains lamellæ of biotite, and besides these minerals magnetite is also to be found.

Some fragments of rock belonging to the series of crystalline schists were collected at Port Sussex. One of these, which to the eye appears covered with ferric oxide, is fine-grained, breaking with a plane fracture pierced with perforations. The ground-mass, when viewed microscopically, is seen to be formed of lamellæ of mica—apparently altered biotite—lying in all directions and associated with an amorphous mass. Some sections with indistinct outlines are visible as a microporphyritic mineral; these sometimes resemble hexagons, and we may have to deal here with altered garnets; in other cases the sections are prismatic, and they may then be classed as felspar. These sections are often filled with a light greenish secondary material resembling chlorite. Little quartz is to be seen, and finally there are rhombic sections which represent an altered rhombohedric carbonate.

We may mention amongst the clastic rocks of Port Sussex, a specimen formed of a greenish fine-grained mass, in which no crystalline elements are visible, and enclosing a granitic fragment, of which we shall speak later. The microscope shows this rock to consist of clastic fragments cemented by a ferruginous argillaceous mass. The broken crystals which are to be seen come from the disaggregation of ancient eruptive or schistose rocks. Amongst these minerals, quartz, plagioclase, microcline, orthoclase, and some splinters of almandine garnet are particularly visible. This rock agrees very well with the composition of an arkose, although we have not ascertained the presence of mica.

The fragment of included granite is a rolled pebble, large grained and very micaceous. Grains of plagioclase, orthoclase, quartz, and mica are to be seen in it. The felspathic sections are altered into micaceous matter. From the smallness of the angle of extinction of this plagioclase it may be classed as oligoclase. Alteration has, one might say, effaced the original characteristics of the mica which is transformed into a greenish matter filled with secondary products. It also happens that fibro-radiated chloritic plates have taken the place of the micaceous mineral. Colourless sections polarising with blue tints are also observed; these are lengthened and coated with mica, and are perhaps cordierite. The quartz has the characters of that mineral in granitic rocks.

Another clastic rock from the same locality presents the appearance of a fine-grained felspathic sandstone, penetrated by oxide of iron, and breaking with a plane fracture. Microscopically it is an aggregation of grains of felspar and quartz with heterogeneous particles of rock. Some of the last named are mica schist, formed of grains of quartz ranged in lines with lamellæ of muscovite between. Other fragments are of a vitreous nature, the glass being altered, having been originally vesicular. In this base there are numerous plagioclase microliths; no bisilicates are to be seen. These splinters may, all things considered, be referred to porphyrites; sometimes a glance is obtained of micaceous lamellæ. Finally, there are found amongst this débris of ancient rocks some grains which seem to be splinters of the paste of a red porphyry. The broken felspars are principally plagioclase; some of the sections being very finely striated, and giving small extinctions, are probably oligoclase; others have few hemitropic striæ, and by this character may be taken as albite; finally, there are others presenting considerable resemblances to microcline. The titanite occurs as an inclusion in a grain of felspar, the latter being perhaps albite. This idea is suggested on taking account of the frequent association of both minerals in the more or less schistose ancient rocks. Orthoclase only plays a subordinate part, sections of felspar being, in fact, rarely seen without hemitropic lamellæ. Titanite is, on the contrary, somewhat common, and it tends to show that the original rock, the disaggregation of which furnished the constituents of that we are considering, contained probably hornblende. The quartz is in irregular fragments, which occasionally, though not often, show undulating polarisation. Their crystalline outlines, which are discovered in certain cases in the form of the sections, or in the arrangement of the inclusions, seem to indicate that this mineral is more likely derived from a porphyritic rock than from a granite. Amongst the minerals formed *in situ*, and developed in the interstices, we may mention certain small greenish scales resembling chlorite.

Some schistose rocks from Port Sussex are of an earthy grey-blue colour, with a homogeneous ground-mass with darker blackish bands, recalling the appearance of an

argillaceous schist. The microscope shows that these are formed of white or reddish mica in lamellæ or fibres having the structure of sericite. Numerous grains of quartz may also be seen, and some débris of monoclinic and triclinic felspars. The colouring matter is iron, in the state of limonite, or a graphitic material. Other schistose rocks resemble true slates; the slabs are slightly shining and blackish. In the microscopic preparations only small groups or threads of quartz, and an opaque graphitic or carbonaceous mass, can be distinguished, all the other elements being concealed by these.

From the same locality we may also mention a black fine-grained quartzite, with a subconchoidal fracture, resembling basalt in appearance. The rock is composed in greater part of small grains of quartz with irregular outlines, fragments of granite, and particles of ancient volcanic rock. Besides the quartz, calcite and decomposed mica are to be seen, also some grains of felspar, and very rarely epidote.

Finally, we have to mention a grey schistoid rock in which a few felspathic grains can be made out with a lens. The microscope shows the clastic origin of the specimen, the cement which unites the constituent minerals being chloritic. In this rock fragments of diabase with epidote, grains of plagioclase, of microline, and of quartz, have been noticed.

VIII.—ROCKS OF MARION ISLAND.

Marion Island[1] and Prince Edward Island belong to the same group. They were discovered in 1772 by the French navigator Marion du Fresne, who named Marion Island "l'Ile de l'Espérance," in the hope that this island should prove an outlying sentinel of the Antarctic continent. In 1776 Cook sailed between the two islands, and, not knowing the names given by du Fresne, called them "Prince Edward Islands," which designation is still retained for the northern and the smaller of the two. From that time to the present both islands have been much frequented by whalers and sealers. Sir James Ross, in his Antarctic voyage, passed in view of these rocky islands, and described the black volcanic peaks of Prince Edward Island.

Marion Island, the larger of the two, and on which alone an opportunity of landing was afforded to the naturalists of the Challenger, is 33 miles round; its shape is an irregular parallelogram, about 11 miles in length, 8 in extreme breadth, and about 80 square miles in area. The highest point is about 4,250 feet above the sea level. It

[1] For the natural history of this group, see Moseley, Notes of a Naturalist, p. 163; *Narr. Chall. Exp.*, vol. i.; Buchanan, *Proc. Roy. Soc.*, vol. xxiv. p. 388.

lies between the parallels of 46° 48′ and 46° 56′ S. latitude, and the meridians of 37° 35′ and 37° 54′ E. longitude.

The island seems to be entirely volcanic. The highest land is in the centre, and irregular slopes lead down to the sea on all sides. These slopes are of very moderate inclinations, and are broken in numerous places by shallow valleys bounded by cliffs where the more ancient flows of lava have suffered denudation. These valleys are now occupied by more recent lava-flows, which still retain their rough pinnacled upper surface. Further, all over the slopes and summits are scattered irregularly numerous small cones, formed mostly of conspicuously red scoriæ. The lava presents in many places in the cliffs a columnar structure. Some sand gathered on the shores of a small fresh-water lake near the sea was full of augite and olivine crystals.[1]

In attempting to reach the actual upper limit of vegetation, Mr. Buchanan made some geological observations, and collected some specimens of the rocks which will be hereafter described. The ascent was up the bed of a small stream, which lay at the verge of one of the modern lava-flows, where it abutted on a low cliff exposing a more ancient flow in section. The more recent flow had a very gradual inclination of not more than 8°. The stream was found to flow over an apparently very recent stream of black cellular lava, the ripples and eddies in which were still perfectly fresh, except in the very centre, where they had suffered some slight abrasion. This lava was basaltic and contained much olivine. Close by the bed of the stream rose several red conical hills. One of these, the highest within reach, consisted of a heap of loose scoriæ disposed in layers, dipping away on all sides at a regular and very steep angle. Few of these pieces of scoriæ were more than six inches in diameter. At the top was a perfectly conical pit, and slightly below the summit, on the north side, were three smaller and similar pits. The scoriæ of which the hill is made up consisted of a highly cellular red ground-mass, with indications of augite, without, however, any perfect crystals being discernible. Besides the red scoriæ, there were some of a chocolate-brown colour, with frothy exterior and compact kernel, resembling almond-shaped volcanic bombs. Besides this hill, there were five or six others precisely similar in appearance and rising out of the same valley. From the top of the hills this valley or depression could be seen to be bounded, towards the interior, by a semi-circular cliff of rocks, in some parts columnar, and open to the sea. Above this cliff rose the snow-covered cones and peaks of the interior, which seemed to be similarly formed to those of the lower ground. On leaving the stream-bed and returning to the eastward over the spur of the mountain, the cliff was found to consist of a light-grey compact doleritic rock.[2]

All the rocks which were collected at Marion Island by Mr. Buchanan, and which

[1] Moseley, Notes of a Naturalist, p. 164.
[2] Narr. Chall. Exp., vol. i. pp. 300, 301.

we have examined, belong to the felspathic basalts; the various specimens differ only in colour, or in the more or less vesicular texture. We will describe first the rocks forming the volcanic cones near the small stream already mentioned. Amongst these, red or black scoriæ are the most frequent. Their surface is very vesicular, the interior part more compact, and having a somewhat waxy lustre. With the naked eye, crystals and grains of olivine are seen scattered through the rock. Microscopical examination shows a vitreous fundamental mass, with lamellæ of plagioclase, the extinctions of which are about 40°, indicating a mixture near anorthite. There are large sections of olivine without any noteworthy peculiarity, the characteristics of this mineral being those which it generally presents in the basaltic rocks. These sections show a perfect cleavage following the base, and are often crowded with trichites. What seems to characterise the crystals of augite is that they very often occur in groups of several individuals, joined with their vertical axes; this is one of the most striking peculiarities of this mineral in the rock under description. Magnetite is present here as in all the specimens from Marion Island. The base is speckled with globulites and trichites; this vitreous matter is often partially decomposed into a brownish palagonitic matter.

The black lava forming the bed of the little stream explored by Mr. Buchanan is generally compact in some places, however vesicular; its grain is that of dolerite. This rock is spotted with white points, and contains macroscopic olivine. Under the microscope it shows the structure and the composition of a felspathic basalt, and resembles in every particular the rocks already described. Augite is present only in very small grains, which are not always easily distinguished from olivine. However, the crystals of this last mineral, even when very small, contain almost always vitreous inclusions of hexagonal or rhombic shape, their outlines being parallel to those of the section; these regular inclusions are not to be observed in the small sections of augite.

A rock labelled "recent lava" has the same macroscopic characters as that just described, but contains even less augite than the preceding specimen. There must be some augitic microliths in the ground-mass, but it is difficult to give any definite determination on account of the opacity of the base. The plagioclases are lamellar, and extinguish under large angles. Very often these plagioclase crystals surround the olivine sections, and are parallel to the outlines of the latter. Olivine does not show the prismatic faces; the sections are always rhombic.

A volcanic bomb collected near the conical hills already mentioned is 10 centimetres by 5, its shape being elliptical; this bomb is reddish brown, rather compact. With the naked eye crystals of olivine and augite are seen embedded in the ground-mass. Microscopical examination shows that this rock is a felspathic basalt. In a brownish base are embedded crystals of plagioclase, olivine, and augite. These minerals are almost always porphyritic; microliths of felspar and of augite are hidden in the ground-

mass. Some crystals of plagioclase are Carlsbad twins: two individuals, tabular following *M*, are elongated following the edge *P*/*M*, the outlines of these sections being the traces of the faces of *p* and *x*. The two individuals are joined on the face *M*, the trace of *p* of one of the individuals coinciding with the trace of *x* of the other. Other sections show at the same time twinning following the albite, Carlsbad, and Baveno laws. The extinction, measured from the trace of the polysynthetic lamellæ, is about 45°,—thus this felspar is a mixture very near anorthite. Large sections of augite are slightly greenish; they do not present any noteworthy peculiarity. Olivine has rarely crystallographic outlines; in some cases the sections of this mineral show the traces of a very obtuse and large dome, and the outlines are very like regular hexagons, but generally the sections present a very corroded aspect.

IX.—NOTES ON THE ROCKS OF KERGUELEN ISLAND.

These notes on the rocks of Kerguelen Island are intended to be essentially lithological, but geological and topographical features will require notice in so far as they throw light upon the lithological description of this volcanic island. We do not require to touch upon the history of early explorations of the island, a history centring round the name of the illustrious navigator Cook, to whom we owe the most exact, but by no means complete, data regarding the island up to the visit of Sir James C. Ross in 1840. The numerous visits of the South Sea whalers added nothing to definite knowledge, and to Ross we owe the first geological observations on the island. MacCormick at the same time devoted himself to the natural history of the region, while the flora was studied by Hooker.

Sir James Ross landed at Christmas Harbour, explored the neighbouring region, and greatly increased our knowledge of it. On the north-west coast also Hooker and MacCormick made their observations. After this memorable cruise many years passed away before another expedition landed on the island. The Challenger touched there in 1874 in order to make arrangements for the British astronomers who were to establish themselves in that locality to observe the transit of Venus. Almost at the same time the "Gazelle" landed the German observing party, who were stationed there for three and a half months for the same purpose. Shortly afterwards the "Volage" arrived with the party of British astronomers under the charge of Father S. J. Perry.

To this party we owe some observations on the south coast, but to the present day the west coast is unexplored, and the centre of the island almost unknown. This ignorance is due to the difficulties of exploration in the marshes and peat-bogs of the interior, amongst the fogs and snows, the torrents and ice-fields, and the terrible storms

which burst upon the western coast. Add to these the extremely rigorous climate, and some idea may be formed of the difficulties opposed to the scientific investigation of a land the climatological conditions of which have justly earned for it the name of "Isle of Desolation."

In addition to the early geological work of MacCormick and Hooker, already incidentally alluded to, we only possess a very few contributions to the lithological constitution of Kerguelen. The rocks collected by the German expedition have been made the subject of a detailed description by Professor J. Roth.[1] The topography of the peninsula on which the German observatory was erected has been studied by Dr. Th. Studer,[2] and he has given geological details of the rocks described by Professor Roth. Mr. Buchanan[3] published his geological notes, taken during the Challenger's visit, and Mr. Moseley[4] described the natural history of the island. The chapter devoted to Kerguelen in the Narrative of the Cruise[5] may be held as reasonably complete with regard to the fauna and flora of the island, and the geology of those parts visited by the Challenger's staff.

These notes are specially devoted to the description of the numerous rock-specimens collected by Mr. Buchanan and others at various points in the island. We have also thought it advisable to condense here all the more important statements regarding the geology of Kerguelen scattered through the writings cited above.

Like most oceanic islands, Kerguelen is essentially of volcanic formation. Sedimentary strata, properly so called, are hardly represented at all. The accumulation of erupted material forms, one might almost say, the entire mass of the island.

Before proceeding to the description of the rocks, we will sketch out those physical features of the island which have a bearing on the facts to be considered.

The Kerguelen group is composed of 130 large and small islands, and 160 rocks. They are grouped round the central island, and are situated in the centre of the South Indian Ocean, nearly half-way between Africa and Australia, and some hundreds of miles south of the route of the clippers which round the Cape of Good Hope on the Australian passage. Its position is approximately 50° S. and 70° E., thus corresponding

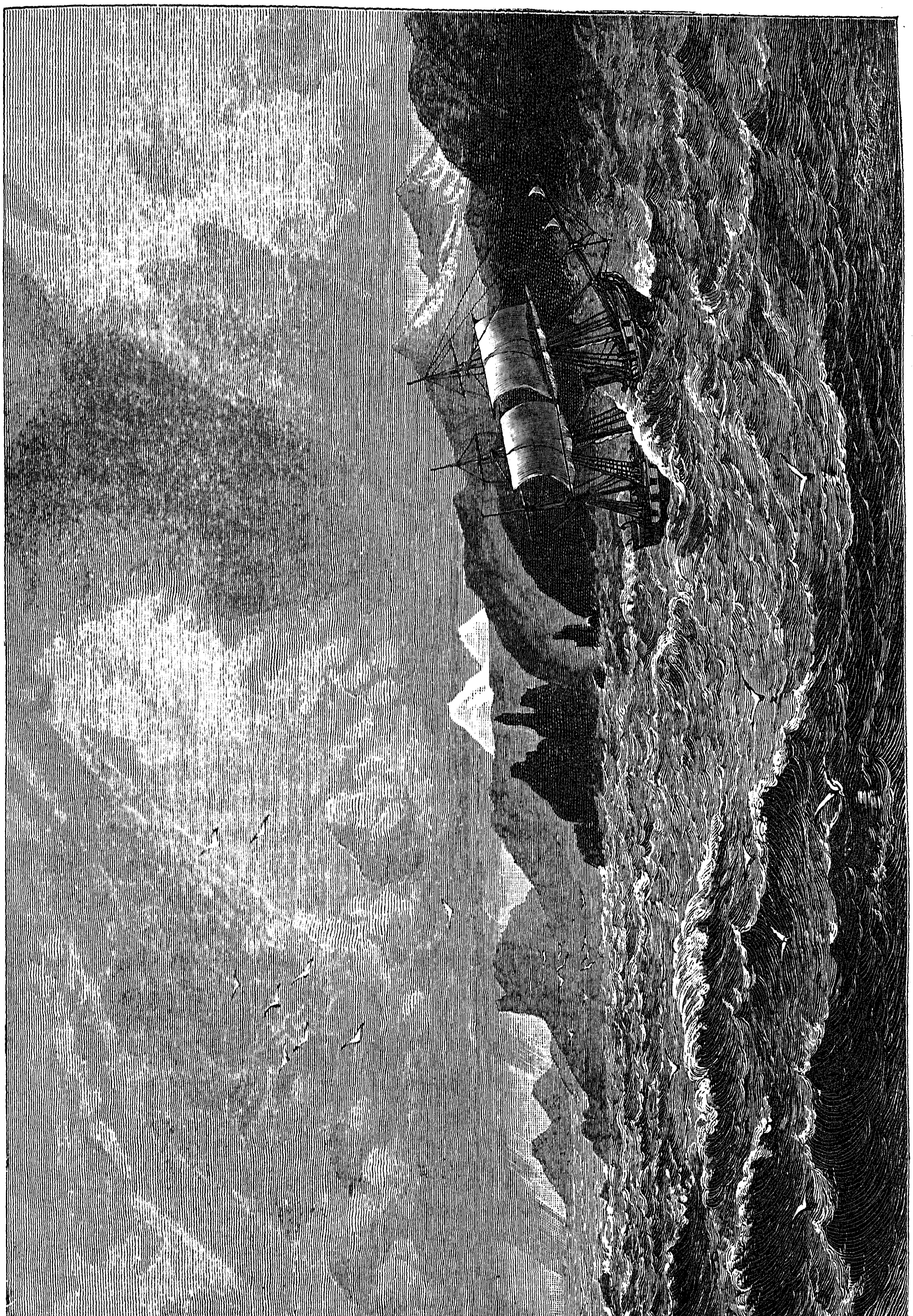
[1] J. Roth, Ueber die Gesteine von Kerguelenland, *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, 1875, pp. 723–735.

[2] Th. Studer, Geologische Beobachtungen auf Kerguelenland, *Zeitschr. d. deutsch. geol. Gesellsch.*, 1878, pp. 327–350.

[3] J. Y. Buchanan, On Chemical and Geological Work done on board H.M.S. Challenger, *Proc. Roy. Soc.*, vol. xxiv. pp. 617–622, 1876.

[4] H. N. Moseley, Notes of a Naturalist on the Challenger, pp. 184–215. The author cites several memoirs on the natural history of Kerguelen.

[5] Narr. Chall. Exp., vol. i. pp. 332–360. See also Relation de deux voyages dans les mers australes, par M. de Kerguelen, Paris, 1782; J. C. Ross, Voyage in the Southern and Antarctic Regions, vol. i. chap. iv., 1847; Die Vermessungsarbeiten S.M.S. "Gazelle" an die Küsten der Kerguelen Inselgruppe (*Ann. des Hydrogr. und Marit. Meteor.*, 1875, pp. 354–365); Rev. S. J. Perry, Report on the Meteorology of Kerguelen Island, 1879; Account of the Petrological, Botanical, and Zoological Collections made in Kerguelen's Land and Rodriguez during the Transit of Venus Expedition, London, 1879, *Phil. Trans.*, vol. clxviii.



closely in longitude with the island of Rodriguez, the Maldives, and Bombay. The greatest length of the island is about 85 miles, its maximum breadth 79, but its area does not exceed 2,050 square miles. This small extent of area may be understood on taking into account the deep indentations of the coast; there is perhaps no other place on the globe where the coast-line is so extended compared with the area. Fifteen great peninsulas run out from the main portion of the island, and numerous deep gulfs penetrate it, cutting the coast-line into long narrow fjords. These are similar in all essentials to those of Norway; they are bounded by cliffs rising perpendicularly, and shutting in an arm of the sea often narrowed at its opening. Royal Sound and Rhodes Bay present classic examples of these extraordinary sinuosities of coast-line.

The actual island is only the skeleton, one might say, of a great region on which the phenomena of oscillation and denudation have left a profound imprint. The deep-sea soundings in the neighbourhood of the land lead inevitably to this conclusion, as they show the portion above water to be the summit of a great submarine plateau. Sir J. C. Ross got soundings of 70 to 80 fathoms for a distance of over 100 miles to the north-east of Cape Francis; the Challenger found no depths exceeding 50 or 60 fathoms for 45 miles to the north of Cape Digby; and between Kerguelen and Heard Island the depth ranges between 80 and 150 fathoms. The "Gazelle" obtained 125 fathoms 40 miles west of Cape Bligh and also 80 miles north of Swain Island. From the results of soundings, it seems probable that Heard Island is the terminal peak, situated at the southern extremity of the chain of submarine table-lands which connects it with Kerguelen. A glance at the chart also shows that the mountain chains of this land are directed north-west and south-east, and that the lofty summit of Heard Island is 260 miles south-east of Mount Ross, the culminating point of the lines of hills which traverse Kerguelen. Taking all these details into account, we must conclude that the two islands belong to the same topographical system, the connecting links being hidden by the waters. The erosion, which has left its traces everywhere; the glacial phenomena, marking their destructive action on the rocks; the oscillations of the ground, testified abundantly by the strata; the action of atmospheric agencies, and even biological facts, combine to give support to the view which presents Kerguelen as the relic of a great land.

A chain of mountains with elevated plateaux traverses Kerguelen from north-west to south-east, and at its southern extremity Mount Ross, the highest peak in the island, rises near the sea. The terraces in the centre, rising to 1500 or 2000 feet, are covered with snow-fields, and glaciers, of less extent now than formerly, are found in several parts of the island. At Mount Richards, for instance, both slopes are covered with them; here the glaciers come right down to the sea, while at other places they do not reach the water, showing rather a tendency to recede. This is the case at Whale Bay and also at Deutsches Bucht, but on the west coast there are several which come down

to the shore. The volcanic manifestations, which gave birth to Kerguelen Island, have now entered on a stage of repose. According to the fishermen, an active volcano still exists on the west coast, and in this region also mineral oils and thermal springs are found.

Low plains are absent, as in all volcanic islands, and valleys with a flat bottom are uncommon. The heights run in lines forming chains, and the small extent of plain is also covered with rocks or mounds connected together. The tabular form is most common for the eminences with which Kerguelen is, in a certain sense, covered. These heights are cut into perpendicular-walled terraces. This arrangement is almost always observed in the case of ranges of hills not exceeding 1000 feet in height. The mountains are sometimes formed by the superposition of five or ten terraces, in other places as many as twenty have been counted. The terminal plateau and the terraces are covered with the débris and alteration-products of the volcanic masses, geodes from amygdaloidal rocks, and nodules of olivine, such as are found in basalt. What has been said applies particularly to the mountains near the coast. The less explored heights of the interior attain an altitude of about 1500 feet, and are composed of solid rocks carved and terraced like those of the coast. Mount Ross, with its double peak, and Mount Crozier belong to the mountains of the interior. According to Professor Roth, these jagged summits are formed of two kinds of rock,—dolerite and trachyte.

We shall now proceed to describe the different localities of the island from which specimens have been collected, indicating at the same time their principal topographical features and the local observations relating specially to the rocks under description. As we stated before, the north-east coast is the only one which has hitherto been explored. In the descriptions we shall follow the coasts, from Christmas Harbour at the northern extremity to Greenland Harbour on the south-east of the island. Describing in succession the rocks of each locality, we will specially lay stress on those parts of the island where the Challenger collected specimens. These localities are designated in our description by the names adopted in the chart of Kerguelen, accompanying this Report (Map V.).

Starting from the northern extremity and going eastwards, Christmas Harbour is the first place we meet with. This bay was named by Cook, who anchored there on Christmas Day, 1776. It is a fine example of a Kerguelen fjord on a small scale, a deep indentation surrounded by mountains with perpendicular cliffs. On each side the land runs out in narrow precipitous promontories. At the northern part of the bay the ground falls more gradually, so that it is possible to land from a boat. At the point of the southern tongue of land stands the well-known Arch Rock, which was formerly united to the island. Now the waves have perforated the central part of this wall of rock, while its base and summit remain connected with the land, forming a natural arch leading to a pile of rocks surrounded by the waves. Above the

precipitous cliffs of the southern side of the bay an enormous mass of black basalt rises with perpendicular walls. As one can judge from the frontispiece to the Narrative of the Cruise, Christmas Harbour as a whole is a magnificent spectacle. The appearance is made particularly remarkable by the imposing mass of the rocks, and still more by the sharp contrast of the straight black cliff and the yellowish green vegetation covering the lower slopes.[1] Christmas Harbour was examined by Ross and the naturalists who accompanied him on his Antarctic expedition. The well-known fossil woods of Kerguelen were discovered here in an excavation named "Fossil Wood Cave," where Ross found a tree trunk 7 feet in circumference. The fossil wood is silicified or calcified, and appears in the form of splinters or blocks, varying in colour from yellowish white to chocolate-brown and black. They are found in beds forming nearly horizontal layers of only a few feet thick, and composed of a soft, whitish, clayey matter filled with black particles resulting from the decomposition of vegetable matter. The fossil wood is sometimes found in trunks measuring a foot and a half in diameter. It occurs in different states of fossilisation; sometimes it is silicified, at other times the bark is transformed into a brownish mass of greasy appearance, but crystalline in structure and effervescing with acids. Crystals of pyrites are sometimes found in the fossil wood. Tree trunks have also been observed, the interior of which is penetrated by the eruptive rocks with which this vegetable débris is associated, but the exterior preserves a fibrous appearance as in silicified wood, although the layer is very thin. With this clearly characterised vegetable débris, the genera of which can readily be determined,[2] layers of vegetable origin are found transformed so completely into carbonaceous matter that it becomes difficult to recognise the vegetable tissue; at the utmost some forms resembling *Chara* can be made out. According to Moseley, the intimate structure does not even appear with the microscope. These carbonaceous deposits are unsuited for burning, being mixed with a great deal of earthy matter, and often found associated with clayey deposits. Hooker stated long ago that these vegetable remains at Christmas Harbour did not belong to the modern epoch. We shall refer again to the geological conclusions to which the facts observed with regard to these deposits lead, and may mention here some other localities where they were found. Professor Roth speaks of their presence on the slopes of the basaltic terraces of Mount Havergal which closes Christmas Bay. Above the doleritic basalt a rock of the same nature is found altered into a reddish argillaceous matter, and a layer of palagonitic tufa. This is overlaid by layers of one to two yards of schistoid material, decomposed into a whitish substance. These are formed of a matter resembling lignite and of fine grains of palagonite; they are not

[1] For the very interesting vegetation of Kerguelen, see the works of Hooker, and for that of Christmas Harbour and Table Mountain, in particular, Moseley's Notes of a Naturalist, pp. 193 *et seq.*

[2] According to Professor Carnoy, who has been good enough to examine the microscopic preparations, the fossil woods are certainly coniferous.

calcareous, and contain fossil wood enclosing crystals of calcite and analcime. Professor Roth, following Bunsen,[1] explains the presence of calcite by the decomposition into palagonite of the volcanic materials associated with these fossil plants. Another layer rests on this, formed also of palagonitic tufa, and containing fragments of fossil coniferous wood. In the zeolitic basalt, forming a cliff toward the south of Christmas Harbour, two beds of lignite occur at a height of 30 or 40 feet above sea level; they are several feet thick, and stretch towards Arch Rock. Silicified tree trunks were seen, according to MacCormick, in the interior of this natural bridge. The lignite is schistoid, of a brownish black colour, and varies much in composition. In some places it is earthy and brittle, but in others it resembles the lignite of the Alps both in colour and fracture. According to Captain von Schleinitz, quoted by Professor Roth, quite similar lignite is found in Breakwater Bay to the south of Cumberland Bay.

To return now to the volcanic rocks of Christmas Harbour. From the position of the Challenger's anchorage the naturalists could easily make themselves acquainted with the disposition of the eruptive masses that border the bay. These form horizontal layers and beds that may be followed along the whole extent of the vertical cliffs which wall the fjord. Here, as in almost all the other parts of the island, the eminences are terraces with flat summits. The plateau extending to north and south of Christmas Harbour is broken by two mountains which rise above it; to the north there is Table Mountain, to the south a hill not yet possessed of a special name; it appears like an enormous block resting on the plateau. A part of these heights has been named Mount Havergal, but it is evident that they are all formed of superimposed layers of basalt. The rocks rising above the horizontal beds of basalt and forming the highest points of the series of mountains, are of phonolitic nature, and similar to those which we shall describe in detail when speaking of Greenland Harbour. They traverse the horizontal beds of basalt, from which they differ in mineralogical character. Their eruption does not seem to have modified the arrangement of the beds which surround them. The latter, forming the principal massif of the region, are basaltic, and the beds are from 10 to 20 feet thick. These basalts are massive, but by climbing the heights one comes to certain layers, the rocks of which are vesicular and filled with zeolites (analcime and prismatic zeolites). These zeolitic minerals are very common in this part of the island, where they are often found as rounded grains in volcanic sand, with which their white colour affords a marked contrast. From base to summit a regular alternation may be traced of beds of compact sub-columnar basalt, and layers of the same material of a vesicular structure. These amygdaloidal rocks appear in two chief forms: one has very small and numerous vesicles, now completely filled with zeolites, the other has large cavities only lined by

[1] *Ann. Chem. Ph.*, 1862, p. 53.

crystals. These zeolites are also frequently found in small veins in the rock. We may say that generally the vesicles are filled with analcime, while a prismatic zeolite predominates in the fissures.

The chain of hills on the south side of Christmas Harbour is higher than that to the north, and as the southern coast is much indented the stratification is clearly shown, and the superposition of basaltic layers in successive terraces becomes very apparent, especially in the promontories.

It is noticeable that all the hills are about the same height, and the general impression left is that the whole formerly consisted of a great plateau which has been deeply trenched by valleys descending towards the sea. This plateau is surmounted by high peaks, so closely resembling recent volcanoes in form that Mr. Buchanan thought they were volcanic cones until a closer examination showed them to be formed of horizontal strata like the plateau on which they stand. This seems to indicate that these peaks are nothing but portions of a higher plateau which have escaped the erosive action of the ice.

The greater number of basaltic rock specimens from Christmas Harbour are characterised by a doleritic structure. To the naked eye they are black, with crystalline grains, homogeneous in appearance, and with a plane fracture. The lens shows felspar. Sometimes they are a little scoriaceous, and show a tendency to assume an amygdaloidal texture, half-formed crystals of olivine and augite standing out. When the vesicular texture is more pronounced, the ground-mass retains the same appearance, its very numerous geodes being filled entirely with compact zeolitic matter of which the species cannot be clearly distinguished. The globules of zeolites generally vary from some millimetres to half a centimetre; they sometimes attain the size of 1 or 2 centimetres, but in this case they form true geodes, and the crystals lining the cavity are generally fibro-radial or prismatic.

Microscopic examination shows that these dolerites are formed of plagioclase and olivine enclosed in grains of augite, which are moulded upon the other constituent elements. These rather large crystals of olivine are often serpentinised, and sometimes give rise to a microporphyritic structure. The crystals of plagioclase are twinned according to the albite law, less often to that of pericline, and more rarely still they show the twin of Baveno. Extinctions of about 30° have been measured on sections which clearly present the striæ of the pericline and albite twins. The augite sections interposed between the felspathic lamellæ are large, but very seldom bounded by crystallographic contours, and usually very pleochroic. When the colour is less deep, the augite at first sight is difficult to distinguish from olivine, but as the latter mineral is usually altered, it is easy to distinguish it from the intact augite. Magnetic iron is represented by small sections derived from the octohedron, or by little rods.

These dolerites are rarely free from alteration; microscopic sections show that they are almost always penetrated by delessite, which even invades the crystals of plagioclase, and they are further often covered with hydrate of iron; grains of red hematite, also, are often seen. As we said when speaking of the macroscopic characters of these rocks, they are often amygdaloidal and filled with zeolites; chabasite is the most important of these, either completely filling the vesicles or lining their walls.

Fine-grained felspathic basalts were also collected at Christmas Harbour. The specimens examined were taken from a bed above sea-level in the northern part of this locality. Viewed by the naked eye these rocks are black, very compact, breaking with a plane fracture, and sometimes presenting large crystals of felspar and olivine. In some cases the rocks are altered, and take a greyish tint; the olivine decomposes into a greenish substance like steatite, and the felspar into kaolin. These altered rocks are often clothed with a thick coating of fibrous zeolite. Under the microscope these rocks are seen to be felspathic basalts; olivine is the only microporphyritic constituent. The larger sections of this mineral are transformed internally into a fibrous greenish dichroic matter, which is perhaps chlorite, possibly even a mica; a brownish frame surrounds the olivine crystals. The ground-mass, in which quadratic sections of magnetite abound, is formed of small grains of augite and opalised felspar microliths. The microscopic vesicles are bordered with fibro-radial delessite, the centre being filled with analcime, and in certain cases by a fibro-radial zeolite.

The olivine of a fine-grained basalt from the same place, and closely resembling that just described, presents interesting peculiarities. It appears in grouped granules, imitating to some extent the peridotic chondres of meteoric rocks. Fig. 19 represents these groupings of olivine grains, which are numerous enough in this rock to form a characteristic feature.

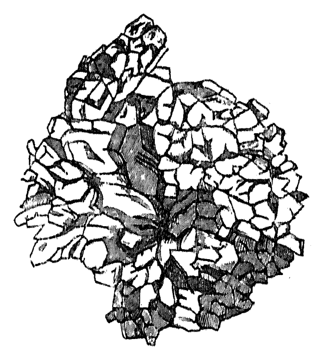


FIG. 19.—Basalt of Christmas Harbour. Grouped granules of olivine, imitating the form of this mineral in the chondres of meteorites. $\frac{1}{10}$ crossed nicols.

Another basaltic rock, from a bed 400 feet above the coast, shows some noteworthy peculiarities. The ground-mass is black and compact; large crystals of felspar and olivine appear in it, and the fracture is irregular. Microscopic examination shows that it is a felspathic basalt like those already described, but while in the former case it was olivine which gave these rocks a microporphyritic structure, here large sections of plagioclase produce this feature. They stand out from a ground-mass of grains of augite, felspathic microliths, and granules of olivine. These large crystals of plagioclase present a character sometimes shown by anorthite and certain albites; their sections appear almost free from hemitropic striæ. It is well known that the felspars which form the beginning and the end of the plagioclastic series have generally less numerous striæ

than the intermediate links. In the present case we cannot explain this rarity of polysynthetic twins by the fact of the sections being cut parallel to the face *M*; they are usually cut, on the contrary, perpendicular to the edge *P*/*k*, for cleavages following *P* and *M* may be observed. In some sections following *P* extinctions have been measured, their value varying from 38° to 42°; this felspar is thus akin to anorthite. The microliths of the ground-mass, on the contrary, must be referred to labradorite.

It is unnecessary to do more than allude to some partly decomposed basaltic rocks which exhibit the usual alteration of basalts; it may simply be noticed that the formation of zeolites often goes on simultaneously with a considerable deposition of siliceous matter, and that the latter, in some cases, takes the place of the plagioclase.

A volcanic conglomerate from the summit of a hill at the south of Christmas Harbour is formed of palagonitic tufa. The black, compact, shining splinters of basalt, varying from 1 to 2 centimetres in diameter, are enclosed in a brownish mass; small whitish layers of zeolites have formed around the lapilli. The brown material has the well-known resinoid character of palagonitic tufas. Opal is sometimes deposited on the rock, and often passes into cacholong. Microscopic examination shows that this tufa is formed of an aggregation of brown vitreous granules. These fragments frequently change to a yellow colour at the edges, without showing any alteration to red, or the characteristic fractures and the phenomena of polarisation, which often accompany the most advanced decomposition of the vitreous matter of these tufas. These amorphous patches are always isotropic. Plagioclase and olivine have crystallised from the magma; no augite is to be seen, the rapid cooling of the paste accounting for the absence of this mineral. The sections of felspar are often prismatic, showing the striæ of the albite twin, but usually this mineral crystallises in little lamellæ with rhombic outlines, and so thin that several of them are superimposed in the thickness of the preparation. These small rhombic tables show traces of the faces *P* and *x*; sometimes they appear as disymmetric hexagons; in this case the face *y* is added to the preceding. Olivine is generally well crystallised, and its sections usually appear with rhombic outlines and inclusions of vitreous matter at the centre. This species sometimes shows crystals joined with parallel axes so as to form groups of several individuals. Magnetite is rather rare, appearing as inclusion in olivine. Vesicles in the vitreous mass contain delessite. The zeolitic substance, cementing the lapilli, forms fibro-radiating layers, which might be classed as natrolite, but the brightness of the polarisation colours seems to indicate the presence of chalcedony penetrating this zeolite.

The rocks forming hills about Christmas Harbour are traversed by dykes, from which Mr. Buchanan collected several specimens. One of these represents a compact basalt in which the naked eye can only distinguish olivine in a blackish shining crystalline mass. Near its contact with the adjoining rock the texture becomes closer, and the basalt passes into the vitreous variety; to this portion of the rock are joined

basaltic lapilli cemented by a palagonitic matter. The microscope shows that this zone of contact, which resembles tachylite, is essentially composed of a vitreous base containing olivine and small rhombic tables of plagioclase, similar to those just referred to as occurring in the palagonitic tufas. The vitreous part, resulting from the rapid cooling of the eruptive rock in contact with the surrounding mass, can be observed in the microscopic preparations joined to the rock forming the central part of the vein. This more crystalline zone is composed of the same minerals; the plagioclase crystals, however, take another form: instead of the tabular sections just referred to, they are prismatic, and often in the shape of skeletons forked at two extremities. Augite is not developed in it, but the brownish glass is darker, and it is filled with trichites and spherulites. Olivine often occurs in twinned crystals, which are sometimes sharply outlined by crystallographic lines in one part of the section, and in the other part shade off into worn and irregular forms. The large sections of olivine in this rock are often enclosed in felspathic lamellæ. On the other hand, the felspathic microliths are surrounded by sections of olivine, which, from this point of view, seems to play the same part as augite does in many basalts. To return for a moment to the rhombic tables of plagioclase, which are confined to the vitreous zone in contact with the surrounding rock. It is natural to suppose that the development of these tabular crystals is in relation with a particular state of consistence of the lava where they were formed. These tabular crystals of plagioclase show the faces P and x, and sometimes those of y. The angle of extinction measured on the face M is negative, and about 32°. This observation suffices to show that this felspar is allied to bytownite.

The coal-beds of this part of the island are associated with schistoid rocks, which resemble certain slaty rocks. At first sight one would mistake them for slates of slight fissility. Their colour is purplish, and the surface shines like some clays, but they are harder, and the streak is not lustrous. No constituents can be discerned by the naked eye. The microscope proves their volcanic nature, and that they belong to the eruptions which poured out trachytic lavas. In ordinary light small prisms of augite and grains of magnetite are seen in a colourless and homogeneous ground-mass. With polarised light a rather large number of sanidine sections are seen in the preparation. They sometimes assume the form of elongated lamellæ, but they are generally placed with their widest faces parallel to the cleavage of the rock. Sections parallel to M often show the Carlsbad twin with k as the plane of composition; sometimes the two twinned individuals are not entirely superposed over the whole extent of the face M. The crystals are generally broken up, and present undulating extinction, induced by the mechanical strain to which the schistose character of the rock is also due. The whole mass seems to have been penetrated by chalcedony.

The hills situated to the north of Christmas Harbour, and reaching an altitude of

1200 feet, are designated Table Mountain. Ross discovered at the top an oval crater-like depression, the long axis of which measured about 100 feet. These heights are formed, like the others already described, of horizontal basaltic layers, but in this case they do not make up the whole mass. Pre-existing hillocks of pale grey rock were surrounded by the lava-flows, contrasting in colour with the black encasing rock. When speaking of Greenland Harbour we shall describe with greater detail the relations and the aspect of these masses surrounded by the basalt, as in both localities the same state of things occurs, and the observations recorded by Mr. Buchanan in that region are more explicit from the present point of view than those available for Table Mountain. Here we limit ourselves to the consideration of the most interesting rocks of the latter region. According to Mr. Buchanan, the basalt assumes a columnar structure and contains great nodules of olivine. The summit of the hill is covered with fragments of basalt which are broken prisms.

All the specimens which we have examined from Table Mountain belong to the basaltic series. We will describe them in the order in which they were collected by Mr. Buchanan when he climbed the hill.

A doleritic rock is first found at the height of about 500 feet above the sea. This appears compact to the naked eye, but crystalline grains may be distinguished. Very small vesicles are scattered through the mass, which is furrowed by long cavities from one to two centimetres in diameter lined with clearly defined crystals of chabasite. Red oxide of iron penetrates the rock in certain points. Microscopic examination shows that this dolerite is entirely impregnated with a greenish secondary mineral. The crystals of olivine which formerly existed are now only recognisable by the outlines of the sections; the interior is entirely converted into this green matter. The plagioclase also is so much altered that it no longer shows polysynthetic striation between crossed nicols; it is so penetrated by delessite that only a very narrow frame of felspar surrounds the sections. The augite appears to have resisted decomposition better, as a rule; reddish sections of it, giving the optical reactions of this pyroxene, are to be seen enclosed between the plagioclastic lamellæ. It is sometimes partly covered by an opaque brownish matter which surrounds and accentuates the crystalline outlines. This opaque matter is formed of elongated or slightly-curved black filaments resembling trichites or crystallites of magnetite.

At the height of 1000 feet, about 10 feet below the terminal plateau, Mr. Buchanan found a specimen of a granular rock, in which crystals of felspar could be distinguished by the unaided eye; its colour is light green by alteration, and its fracture irregular. Microscopically it appears to be a much altered dolerite. As in the preceding rock, olivine has almost entirely disappeared, but plagioclase in large lamellæ and augite have better resisted decomposition. Spherules of chalcedony and chabasite are developed in the pores. Silica has also penetrated the felspar, and the plagioclase thus assumes

brilliant colours of polarisation. A greenish secondary product covering a considerable part of the preparation appears, and sometimes assumes a vermicular form very like that of helminth.

Two specimens of basalt were collected on the summit of Table Mountain. One of these was taken from a bed the rocks of which showed columnar structure. It is a very compact bluish black basalt, with a plane fracture, and contains large inclusions of olivine. Under the microscope the rock is very fine-grained, and in the ground-mass greenish brown augite crystalloids predominate, embedded in plagioclastic lamellæ. Fragments of olivine detached from a large inclusion of a peridotic rock are also to be seen. Rather large patches, composed exclusively of augite grains, are sometimes to be observed. The bottle-green nodules of olivine, enclosed in this basalt, are formed by an aggregation of minerals which corresponds to lherzolite (see fig. 20). Olivine forms the principal mass of this inclusion, its grains appearing irregular, colourless, and split up without a trace of definite cleavage (*a*). A lamellar rhombic pyroxene is associated with this mineral; its colour is light green, and it is probably enstatite (*b*). Finally, transparent brown isotropic sections of picotite and greenish augite (*c*) are embedded without crystalline outlines amongst the minerals already mentioned, moulding themselves upon them.

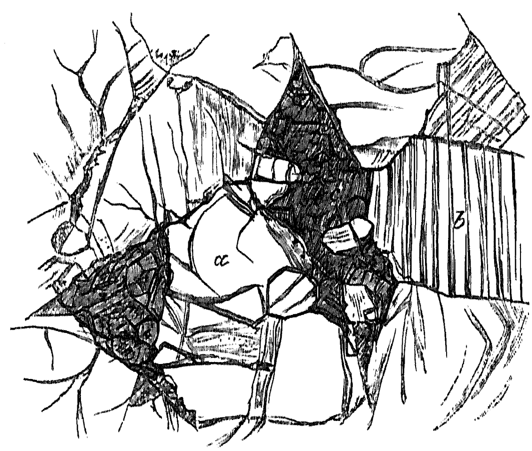


FIG. 20.—Basalt of Table Mountain.

Microscopic section of an inclusion in this rock. The inclusion is formed (*a*) of olivine in cracked, colourless, irregular grains; (*b*) rhombic pyroxene, lamellated, and light green in colour; (*c*) greenish grains of augite. The inclusion also contains brownish sections of chromite or picotite, which are not figured. $\frac{1}{20}$ crossed nicols.

Another preparation from one of the peridotic nodules of the Table Mountain basalt shows a slightly different composition. In this case the rock appears to be formed only of olivine, the aggregated grains of which have experienced a slight serpentinisation along the cracks.

The second specimen from the upper part of the mountain is, like that briefly described above, an ordinary black, compact, fine-grained basalt, in which the eye can detect nothing but grains of olivine. The ground-mass is formed of small plagioclastic lamellæ, not much lengthened, and of brownish granules of augite with which magnetite is associated. Large fragments of olivine without crystalline outlines give the rock a microporphyritic structure. One cannot help recognising these fragments of olivine as foreign inclusions, and similarly a like origin must be admitted for the large sections of chromite which the rock contains. These may be as much as two to three millimetres in diameter; they are very irregular in outline, and often surrounded by a zone of magnetite.

A volcanic bomb from Table Mountain is formed of a medium-grained, greenish black rock, reddened on the surface, and furrowed with long hollows full of large crystals of chabasite. Under the microscope it is seen to be formed of a slightly transparent greyish mass speckled with grains of magnetite. This ground-mass, which cannot well be analysed even under the highest powers, has an indistinct structure which may be compared to marbling. Skeletons of felspar forked at both extremities appear in this ground-mass. These plagioclastic sections are sometimes larger, and in that case are almost always cracked in every direction, and appear in parts converted into chalcedony. The olivine is decomposed into serpentine, and augite does not appear to be present.

A fragment of altered vitreous basalt may be mentioned, finally, amongst the specimens from this locality. The rock has a reddish brown colour, is scoriaceous, and very much decomposed, some parts passing into palagonite, others being almost earthy. The rock is entirely impregnated with iron, and is transformed into palagonitic matter in the last stage of decomposition. The ground-mass is brownish and opaque, filled with colourless microliths of felspar which are aggregated in star-like groups. Like the larger crystals to be described, the microliths are entirely converted into zeolites. The larger sections of plagioclase have retained their form only, and give the optical reactions of zeolites. Some small and very distinct sections of olivine also appear, filled with zeolitic crystals, and the latter are developed in the cracks of the rock as well. Other sections of olivine are less profoundly decomposed, being only impregnated by ferruginous matter and products of alteration along the fissures. If augite exist in this rock, it must be entirely disguised by the products of its alteration. A few crystals of apatite have been observed.

A specimen from Arch Rock may be described before considering the rocks of Cumberland Bay. This natural arcade forms the extremity of the southern headland enclosing Christmas Harbour. The specimen examined is a black dolerite, coloured greenish by alteration, of moderately fine grain, and breaking with an unequal fracture. Its microscopic structure is that of a characteristic dolerite; lamellæ of plagioclase are enclosed in reddish grains of augite, which constitute, so to speak, the cement of the rock. Large crystals of olivine, retaining their crystallographic form, but largely altered into serpentine, are observable. Delessite has been developed at many points; its sections appear generally triangular, or with straight lines, the outlines of this green secondary matter being usually defined by the intercrossed lamellæ of plagioclase, which themselves are more or less penetrated by delessite. The latter mineral also lines the geodes, in the centre of which calcite has crystallised. Arch Rock has also yielded amygdaloidal specimens with fibro-radial zeolites closely resembling those of Christmas Harbour.

Cumberland Bay is the first important indentation of the coast to the south-west of Christmas Harbour, but as neither the Challenger nor the "Gazelle" Expeditions collected rock specimens from this deep and narrow fjord, our geological knowledge of it is limited to the observations of Ross. He states that a hill 300 to 400 feet in height, formed of a basaltic conglomerate and terminating in a crater, stands at the head of the bay. Veins of an amphibolic rock are injected through the mass. On the south there is a bed of carbonaceous matter 10 feet wide and 1 foot thick, covered by an amygdaloidal rock. A little farther south another bed of coal, two feet thick, appears. The schistoid rocks at the north of Cumberland Bay show impressions of *fucus*. Ross describes the rocks of the bay as "trap," an expression which may apply to basalt or to more or less amygdaloidal dolerite. Buchanan observed that, although geodiferous rocks are very common in this part of the island, the nature of the geodes differs in various localities. At Cumberland Bay the cavities are filled with quartz crystals; at Howe's Island, of which we shall speak presently, chalcedony and agate predominate; on the other hand, the amygdaloidal cavities of the basalt are lined or filled chiefly with zeolites. To sum up, quartz crystals seem to be confined to Cumberland Bay; zeolites are chiefly found at Christmas Harbour, while Mr. Buchanan observed none at Howe's Island or Betsy Cove.

The bay of Rhodes is shut in between Bismarck Peninsula and the large island of Prince Adalbert, and there amygdaloidal basalts occur, some specimens of which we have examined. The cavities are filled with chabasite, the rocks themselves much altered, of a greyish colour, and entirely impregnated with zeolites, the constituent minerals not being apparent to the naked eye. Microscopic examination shows that these fine-grained rocks are composed of plagioclastic lamellæ, augite, magnetite, and several black opaque elements; but they contain little or no olivine. The microscopic vesicles are filled with closely-packed grains of chabasite.

Professor Roth mentions the occurrence at Port Marie in Rhodes Bay, Prince Adalbert Island, of some amygdaloidal dolerites with nodules of quartz and chalcedony with coatings of the same minerals showing impressions of the rhombohedron of calcite—$\frac{1}{2}$ R. Calcite and zeolites are also observed in these rocks. At a height of 500 feet a doleritic basalt decomposing into a ferruginous red clay is found.

To the north, and almost at the entrance of Rhodes Bay, is Howe's Island, long supposed to be a peninsula. It was visited by the Challenger naturalists, who found amygdaloidal rocks in the north-east, the geodes of which were exclusively filled with agate. The hill summits were strewn with these nodules, which remained in their places after the containing rock had decomposed.

Amongst the rocks of this island, those may be described which form the top of

the chain of hills visible from the Challenger's anchorage. The specimens which we examined must have been collected as fragments, as their contours are rounded. They are greyish in colour, somewhat coarse-grained, contain augite and felspar visible to the naked eye, also many zeolites, and greenish specks of a secondary substance, probably delessite. Microscopical examination confirms the macroscopical determination of this rock as a coarse-grained dolerite. The plagioclase is transformed into chalcedony and micaceous matter. The augite is purplish and without crystallographic outlines. Titaniferous iron is very abundant, appearing in the preparations as elongated or irregular rods. Olivine seems to have almost entirely disappeared, hardly any trace of it remaining. In the cracks of the rock colourless patches are to be seen which give scarcely sensible chromatic polarisation, and are obviously of zeolitic nature. These zeolites are usually framed by a zone of delessite which lines the cavities with a mammillated coating. Hematite is also a somewhat common mineral.

Fine-grained basalts were also found on the summits of these hills. These are black and compact, and crystals of augite, plagioclase, and olivine may be distinguished by the lens. Microscopically the rock appears to be a felspathic basalt, the ground-mass being made up of microliths of felspar, grains of augite, and magnetite. In this there appear large sections of olivine and augite, and broad lamellæ of much altered plagioclase. A second specimen of fine-grained basalt from the crest of the hills of Howe's Island shows a composition analagous to that described, only the microporphyritic element is almost exclusively plagioclase.

The basalts just enumerated are traversed by a dyke of bluish black rock, in parts vesicular, and of medium grain. Examined with a lens it shows augite, plagioclase, and olivine entirely transformed into an almost earthy serpentinous mass with a slightly greasy lustre. The microscope shows the dyke to be composed of a felspathic basalt, resembling all those of the island which we have examined. The ground-mass is made up of small plagioclastic lamellæ, microliths of augite, and crystallites of magnetite. Large sections of plagioclase, giving the extinctions of anorthite, appear in the mass. This plagioclase is finely striated, and is sometimes twinned according to the Baveno or pericline law; at other times it is zonary, and very rich in brownish vitreous inclusions. The sections of magnetite sometimes attain pretty large dimensions, and, with the augite, determine the microporphyritic structure.

We have mentioned that the summits of the hills of Howe's Island are strewed with geodes of agate. Mr. Buchanan observed that these nodules, derived from decomposed amygdaloidal rocks, are often worn on a part of their surface, as if they had been planed, while in other cases they are covered with very sharp striæ. The planing of part of the surface may be looked upon as the result of glacial action. As we shall see farther on, this action must have been formerly exerted at Kerguelen on a far larger scale than is the case at present.

Proceeding towards the south-east we meet Bismarck Peninsula, which runs out, indented by numerous fjords, between Rhodes Bay and Whale Bay. The rocks collected here by the German expedition were examined by Professor Roth. He speaks of a mountain formed of doleritic rock on a very narrow headland at the western extremity. This hill has the terraced structure so often to be seen in Kerguelen. Other specimens from this locality are altered doleritic basalts of a greyish colour, and fine grained. In these the microscope shows crystals of augite, magnetite, and olivine embedded in a vitreous ground-mass. The eastern coast is deeply cut into by the bays of Sontags Harbour, Successful Harbour, and Port Palliser. Mount Palliser rises to the north of Sontags Harbour, and its terraces incline gradually towards the north-west as far as Cape Neumayer. These heights and those situated between Sonntags Harbour and Port Palliser are composed of amygdaloidal dolerites with chabasite, calcite, analcime on calcite, heulandite, geodes of chalcedony, and crystals of quartz.

The great peninsula of Bismarck is bounded on the south by Whale Bay, at the head of which—named Kaiserbassin by the Germans—a river enters from the Lindenberg glacier. The bed of this watercourse is full of flat pebbles. The glacier terminates about six nautical miles from the shore in a wall of ice 75 feet high, the base being at an elevation of 350 feet above sea level. The whole valley was probably filled by this glacier at one time. Professor Roth enumerates amongst the stones of the valley, more or less altered doleritic basalts and amygdaloidal rocks, with brownish silica and geodes of zeolites, the latter being covered by a thin coating of delessite. Among the secondary minerals he mentions quartz, probably replacing natrolite, and also agate, calcite, and geodes of quartz. A trachytic rock, containing sanidine, augite, and magnetic iron, crops out at the mouth of the river, and at another place the same rock traverses doleritic basalt as a dyke from 180 to 250 feet thick.

The Roon peninsula runs out between Irish Bay and Winterhafen. The rocks of the hills on this promontory are doleritic, and contain geodes of quartz and agate with a little calcite. The same rocks with identical secondary minerals appear again at Winterhafen, and according to Professor Roth, a greyish sanidine rock also occurs. The hills of the extremity of Uebungs Bay—which is only the eastern extension of Winterhafen—are crowned with lakes, and the rocks are similar to those described above, yet one rock seems to contrast strongly with all others found in Kerguelen. Professor Roth says that in this locality the basalt traverses a greyish pyritiferous mass, which effervesces with acids, and contains much quartz and little felspar. The appearance of this rock recalled that of the dolomite of the schisto-crystalline series, but he acknowledged that there was difficulty in pronouncing as to its age. Professor Roth gives some details of the rocks of this part of Winterhafen, which enable us to recognise the same uniformity

of lithological constitution as we have already had occasion to notice at other parts of the island. A little farther along the coast to the west is Irish Bay; it receives the river descending from the Naumann glacier, which stops at a distance of five nautical miles from the end of the bay. At the foot of the glacier doleritic basalts are found *in situ;* these are sometimes amygdaloidal, and marked with glacial striæ; a trachytic rock enclosed in the basalt may also be observed.

Foundry Bay succeeds that last mentioned. It is a fjord barely two-thirds of a mile wide at the entrance, with Gazelle Basin situated in its western angle, and Schönwetter Harbour at its eastern extremity. The rocks from the shores of this bay are doleritic basalts, with olivine and geodes of chabasite, quartz, and agate. Amygdaloidal dolerites, containing fine geodes of heulandite, quartz, and chalcedony, are found at Schönwetter Harbour. There are also fine-grained basalts, and tufas of the same lithological nature.

Continuing towards the east we reach the most thoroughly known peninsula in Kerguelen, that named Observations Halbinsel by the German explorers, and made the object of a detailed topographical survey by Captain von Schleinitz, who commanded the "Gazelle."[1] Dr. Th. Studer, naturalist to the German expedition, published a memoir full of facts regarding this part of the island. He remained for more than three months in the neighbourhood of Betsy Cove, and his work comprises a most complete set of observations on the topography and geological conditions. The latter are treated with special detail, comprehending the study of the basaltic and trachytic eruptive masses, the deposits formed by running water, glacial phenomena, erosion by sea and rivers, and recent oscillations of the ground. It is impossible to give an abstract of this work here, the reader must therefore refer to the original paper. We may, however, state the principal features of the physical geography of this peninsula, and summarise the chief varieties of rocks collected by Dr. Studer and determined by Professor Roth.

The Strauch hills, attaining a height of 1150 feet, and Castle Mount, with an elevation of 1550 feet, stretch towards the west, and farther in the same direction lies the valley of Cascade River, one tributary of which flows from Lake Margot, another having its source a little farther north. Mount Crozier rises to 3000 feet at the south of Lake Margot. The peninsula on the north and east is simply a plain about 30 feet above sea level, covered with rolled pebbles, and diversified by lakes and marshes. On this plain, to the south of Accessible Bay, are situated the Tafelberg (275 feet), and three isolated summits—Mount Campbell (about 460 feet) lying farthest north, Mount Peeper (650 feet) next it, and to the south of these the crater-shaped Mount Bungary.

In what follows we shall give special prominence to the observations of the British naturalists, which only refer to the special point of Betsy Cove, where the Challenger

[1] See *Annalen der Hydrographie*, Bd. ii. No. 19, p. 220, 1875.

anchored, and on the shores of which the explorers collected specimens. Mr. Buchanan observed that the hills here have the same structure as in the north, the eruptive sheets appearing in the form of horizontal layers. The hills, however, are farther from the coast, and a plain, broken only by Mount Campbell, extends from their base to Cape Digby. Mr. Moseley has drawn attention to the glacial phenomena in the neighbourhood of Betsy Cove. A series of *roches moutonnées* appeared to the north of the port where the Challenger anchored. Betsy Cove and the neighbouring fjord of Cascade Reach are two deep indentions opening into the great basin marked on the Admiralty chart as Accessible Bay. Here there also opens a large valley, running far into the country between two lofty chains of hills. The hills near this valley are rounded on the summit, probably by glacial action. According to Moseley, the whole region has been subjected to great denudation since it was glaciated, and the striæ and moraines must consequently have been obliterated to a great extent. Everything seems to show that the hills were cut out of a continuous sheet of volcanic rock, which formerly spread over the whole region; the summits are capped with basalt, showing columnar structure in their sections.

We shall first describe the compact coarser-grained specimens of basalt from Betsy Cove. They are black, with an unequal fracture, formed by an aggregation of crystalline grains, amongst which yellowish patches of olivine, measuring half a centimetre, plagioclase, and augite may be detected by the unaided eye. Under the microscope large and sometimes very elongated microporphyritic sections of olivine appear. This mineral is decomposed into a yellowish matter, not showing the usual green tint of serpentine. The augite is transformed into a green substance, delessite or grengesite, which also tends to replace the felspar; it is found in every hollow, and surrounds all the constituent minerals. The plagioclase crystals show an angle of extinction, which classes them as anorthite or some very basic felspar. Large sections sometimes show at the same time the albite and Carlsbad twins. The larger minerals are embedded in a network of small plagioclase crystals, augitic microliths, and decomposed grains of olivine.

Other specimens from the same locality are finer grained, and also distinguished by a cellular structure. They are all greatly altered, some specimens so much so that they appear earthy, are covered with oxide of iron, and are frequently red, with whitish markings. The vesicles, from half a centimetre to a centimetre in diameter, are usually lined with well-formed crystals of chabasite. Doleritic structure does not appear when slices are examined microscopically; microporphyritic structure is very rarely seen, and, when observed, is due to a larger development of crystals of plagioclase. These large sections of felspar are traversed by cracks, pervaded by a light-brown substance, presenting the characters of silica in the state of chalcedony or opal. The silica sometimes partly penetrates the mass of the felspar, but it is not found in this mineral only, as it occurs in all the holes, where it assumes a purplish or brownish

colour. The concretionary structure and brilliant polarisation colours distinguish it clearly from chabasite. Felspar alone is usually found retaining its natural colour; augite is transformed into delessite or grengesite, and the olivine is covered with oxide of iron, or even filled with hematite, or else serpentinised. Chabasite, the rhombohedric forms of which are visible to the naked eye, fills all the vesicles with closely-packed grains. These react feebly between crossed nicols; they show striations and twinnings, and the other phenomena which have been particularly studied by Professor Becke.

Professor Roth's lithological observations on the rocks of Betsy Cove go to show what a large part doleritic basalts containing zeolites play in the whole peninsula. We need refer to a few only of the rocks of another nature which he has determined from specimens collected by the German expedition. A rolled pebble of red porphyry was found at the foot of Mount Peeper, and this, according to our author, seems to prove the existence of ancient rocks in Kerguelen. We shall refer to this point again. The specimens from the eastern part of Mount Peeper have been found to contain half-fused fragments of sanidine rock. This clearly proves that the trachytic masses existed prior to the basaltic eruption. This conclusion will be confirmed by considering the relation between the sanidine rocks and the basalts of Royal Sound and Greenland Harbour.

Professor Roth records from the neighbourhood of Mount Crozier, besides the usual eruptive rocks of Kerguelen, fragments of a bluish grey sedimentary rock, the age of which cannot be determined. It is related to a labradorite-porphyry coming from the south-western extremity of Lake Margot. This rock is compact, and the greyish blue ground-mass contains triclinic felspar and grains of pyrites, its appearance recalling the rocks of ancient type. The specimen effervesced strongly with cold acids, and after treatment with hydrochloric acid the ground-mass appears lighter in colour, while the felspar crystals are much corroded. Microscopic preparations show that the ground-mass is much decomposed, and contains triclinic felspar, a chloritic mineral probably derived from augite, altered olivine, and magnetic iron. Another rock, coming from the series of hills in the Studerthal, to the north-east of Mount Crozier, has a granular structure, and contains chiefly triclinic felspar, plates of black mica, and an altered mineral possibly derived from hornblende. The rock effervesces slightly in acids. It appears to contain some crystals of orthoclase, and Professor Roth was led to class it with the ancient eruptive rocks such as micaceous diorites.

The great peninsula, the rocks of which have now been described, is bounded on the south by a large bay, Royal Sound, occupying the south-eastern extremity of Kerguelen. Here the British and American stations[1] were situated in 1874. Before

[1] The American transit of Venus mission was established at Royal Sound, near Molloy Point. Dr. Kidder, the medical man of the party, has published his botanical and zoological observations in Nos. 2 and 3 of the *Bulletin of the United States National Museum*, Washington, 1876.

describing the rocks of this fjord, we may consider those from Prince of Wales Foreland, a long and mountainous promontory which stretches from the peninsula already described towards the entrance of Royal Sound; the northern boundary is Shoal Water Bay. According to Mr. Buchanan this high promontory is formed of columnar basalt, in some places weathering into spheroids. The rock contains large nodules of olivine. Flat-topped hills extend into the interior beyond this tongue of land with its serrated rocks. They in turn are of basaltic nature, and contain much olivine, but the columnar structure gives place to a bedded arrangement, which in some cases is schistoid.

Besides the basalts reported by Mr. Buchanan, we have found amongst the specimens from this locality a limburgite, a lithological type we have not yet noticed as occurring in the island. Externally it resembles a basalt, but the mass is more shining and bluish black in colour. Bottle-green grains of olivine are visible to the unaided eye; with the lens smaller crystals of augite become visible. Large sections of brownish olivine appear in the homogeneous vitreous ground-mass. As a rule they have sharp crystallographic outlines, sometimes, however, they are corroded; they present no peculiarity, except for some large transparent inclusions of chestnut-brown chromite. Augite occurs as well-developed light green crystals, showing distinct outlines, and often twinned polysynthetically. Numerous augite microliths, usually very elongated, occur in the ground-mass. Magnetite is abundant in the form of regular sections, but no felspar is to be seen. The cavities of the rock are lined with fibro-radial zeolites.

On doubling Prince of Wales Foreland one enters the great bay of Royal Sound, studded with islands and reefs to the number of more than a hundred. The gulf is wide and deep. All the islets and the hills of the neighbouring land terminate in tabular summits. The rocks forming islands in this fjord are strewn with erratic blocks, the number of these ice-borne fragments seeming to increase as we approach the bottom of the bay. The hills are the same as those of Betsy Cove; in fact, if the great valley there were filled by the sea, the numerous hills of the northern part would appear as islets, and give to the bay the appearance of Royal Sound in miniature. It is almost certain that all the islets and reefs were connected to begin with, forming part of a sheet of lava which descended with a slight slope from the land to the sea. The slope was covered by a great glacier shut in by the hills which now border the sound on the south and north. After having planed down the whole surface over which it flowed, the glacier hollowed out the deep channels between the harder rocks, that now form islands in the bay. During this glacial period, or at some subsequent time, all these islands were covered by the sea in consequence of subsidence; the icebergs, broken off from the glacier as it entered the sea, deposited the erratic blocks upon the summits of the islets of the Sound. At this time, also, moraines must have been carried away.

Hog Island is the only one in Royal Sound the rocks of which are known. Specimens

were collected by the German expedition and examined by Professor Roth. He reports amygdaloidal doleritic basalts with geodes of quartz as the chief rocks of this island, which rises about 400 feet above the sea. Trachytic rocks covered with a brownish altered layer occur on the summit. In the ground-mass of this trachyte there are crystals of sanidine reaching 15 millimetres in diameter; crystals of a shining triclinic felspar also occur, but these are rarer, and, finally, there is augite, without crystallographic outlines. The microscope also shows magnetic iron and some lamellæ of mica. A trachyte resembling that of Kühlsbrunn is found in the same island. It is a greyish rock, of a scaly grain and slightly slaty. Under the microscope, isolated brown crystals of hornblende appear. Professor Roth could not recognise with certainty the presence of triclinic felspar.

Mr. Buchanan collected from the rocks cropping out near the shores of Royal Sound several specimens of amygdaloidal dolerites, the vesicles being filled with zeolites. One of these much altered rocks has large crystalline grains, and is penetrated with a great number of fibro-radial zeolites, and with limonite. Microscopically it shows the doleritic structure, but this is not developed here in a very characteristic manner. The crystals of olivine have too sharp crystallographic outlines; they lead rather to a transition of the doleritic structure to that of the basalts, properly so called. In thin slices of this rock the microscope shows large plagioclastic lamellæ, between which grains of augite are embedded. The olivine is impregnated with hematite, and sometimes transformed in the interior into a fibrous matter like serpentine. In certain cases the augite appears in large sections, generally much altered and charged with iron. There are numerous rods of magnetite or ilmenite, and calcite is much developed in the vesicles, where it is associated with zeolites.

Other rocks from the same district are identical with the preceding. We may, however, add to the foregoing description that microscopic examination shows the regular association of plagioclase and augite, the former being united to the pyroxene parallel to one of the pinacoids. Small yellowish transparent rods also appear, sometimes arranged in parallel series, and recalling the form and grouping of magnetite trichites. These little rods are entirely transformed into limonite, but the larger sections of magnetic iron have not been affected in this way except a little on the edges.

Finally, at Royal Sound greenish yellow light scoriaceous rocks are found, almost earthy from alteration. The only mineral to be seen is augite in large black crystals, which stand out from the decomposed rock. Thin slices show that it is formed of a green basaltic glass full of bubbles and partly decomposed into palagonite. This vitreous matter is stretched out in filaments, and passes in some places from brown to yellow. Its structure is sometimes as fibrous as that of pumice. The vesicles are not filled with zeolites, but limonite is found almost everywhere in the preparations. Besides the very numerous crystals of magnetite, there are sections of

brown hornblende well characterised by their contours, their cleavages, and their extinction. Augite is present as greenish sections. These two minerals are rather uncommon as large crystals in the rock just described. They bear traces of fusion or corrosion, their outline being rounded by the action of the vitreous magma. By the use of the highest powers little microliths of augite are seen in great abundance; felspar is extremely rare.

There remain to be described some rocks collected in the bed of Channer River which flows into Royal Sound. The specimens are flat-rolled pebbles of augitic trachyte, which contrast by their grey colour with all the other rocks that have been described. Crystals of sanidine visible to the naked eye appear in a greenish grey ground-mass; small prisms of augite may be distinguished with the lens. These stones have an indistinct schistoid structure, and microscopic examination of thin slices shows them to be microporphyritic. This structure is determined by large sections of sanidine of irregular outline, and by an aggregation of little green crystals of augite, which imitate by their general appearance crystals of hornblende whose place they take. These augitic pseudomorphs of hornblende are accompanied by numerous grains of magnetite. The hornblende has, as a rule, entirely disappeared, and zeolites fill the spaces between the microliths of augite (fig. 21). Sometimes, however, at the centre of the aggregation there remains a brownish, very pleochroic remnant of hornblende. The ground-mass is composed of rather elongated lamellæ of sanidine, twinned according to the Carlsbad law, pressed against each other, but still exhibiting a certain linear arrangement suggestive of fluidal structure. The lamellæ are sometimes less regularly disposed, forming a network; the forms of the felspar microliths in the ground-mass are less distinct. Almost all the constituent minerals are surrounded by a zone of green microlithic augite. Titanite is often present. A fibro-radial zeolite, showing the black cross of spherulites, lines the hollows and penetrates the spaces between the minerals.

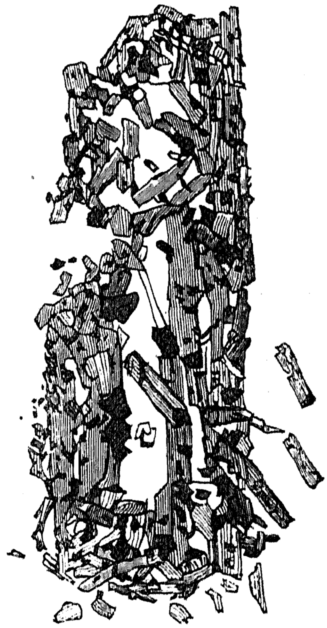


FIG. 21.—Augitic trachyte from Royal Sound.
Small grouped crystals of augite, imitating as a whole the form of a hornblende crystal, whose place they fill. This replacement of hornblende by augite has been accompanied by the formation of numerous grains of magnetite, and in the centre of the group of augites a small brownish pleochroic remnant of hornblende may be seen. Usually, as in the drawing, this mineral has quite gone, zeolites filling the interstices between the augite microliths. $\frac{1}{35}$ crossed nicols.

Mr. Buchanan describes a peculiar hill at the other entrance to the Sound, almost

opposite Prince of Wales Foreland, which has a very similar structure to that of certain hills at Christmas Harbour. It has an embattled appearance like a castle, and is known by the name of "Cat's Ears." The rocks at the summit look like ruins; they are greyish, and contain fragments of scoriaceous lava, which also forms a layer immediately beneath the battlemented crags. The rock contains large crystals of augite, with sharp outlines, but they are always broken and rounded when observed in the volcanic sand formed by the decomposing rocks. The sand has been sorted out by the wind, the white grains, which are lightest, being carried away and only the black particles left. These crystals and the rocks themselves clearly show the erosive action of the wind, the former having lost all regularity, the latter being deeply cut into on the side facing the prevailing winds. Here, as in Heard Island, where the same thing can be observed in even greater perfection, the wind constantly blowing from the west carries along the sand and drives it with great force against the rocks, cutting and carving them in a characteristic manner.

From this hill Mr. Buchanan, from whom we borrow these facts, could see another very similar at the base of the Sugar Loaf. From a distance it resembled a druidical circle, but the short time at his disposal prevented him from examining it more closely or visiting the Sugar Loaf.

Amongst the rocks we have examined, there were no specimens from "Cat's Ears," nor from any other hillock of this part of the Sound, except Coronet Hill, near the south-western entrance. These rocks may be classed as augitic trachytes, trachytic tufas, and basalts.

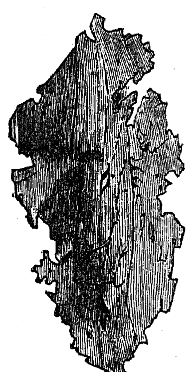


FIG. 22.—Trachyte from Coronet Hill, Royal Sound.
Section of corroded sanidine with undulating extinction. $\frac{1}{20}$ crossed nicols. Polarised light.

The specimens of trachyte are greyish, rather compact, with an irregular fracture; only small crystals of sanidine can be detected with the lens. Thin slices, when examined, show that the rock is composed of an isotropic mass containing small crystals of sanidine, twinned according to the Carlsbad law, and also larger individuals of the same mineral. The latter are always much broken up, and exhibit undulating extinction (see fig. 22), as if they had been submitted to strain, a supposition which is strengthened by the linear arrangement of the augite microliths. These small prismatic crystals extinguish at nearly 40°, and are invariably bedded with their vertical axis in the plane of the preparation. Many sections of magnetite are to be seen; these are usually collected in the place occupied formerly by hornblende crystals, of which scarcely a trace remains. These crystals of hornblende are always surrounded by small green crystals of augite.

Other specimens of much-altered whitish trachyte readily fall into powder. They are as light as pumice, but of closer texture; they greatly resemble the preceding rock, except that the light vesicular vitreous matter, passing into a pumiceous structure, plays a more considerable part. Crystals of plagioclase, intimately associated with sanidine and apatite, may be mentioned as accidental elements.

These trachytes are accompanied by reddish pumiceous trachytic tufas. Irregular fragments may be seen by the naked eye embedded in a slightly scoriaceous paste. Thin slices show that these tufaceous rocks are composed of a greyish mass, which is isotropic in some places, and almost everywhere impregnated with iron. The little fragments of rock enclosed in this grey mass are trachytic; sanidine is the principal constituent in them, associated with green microliths of augite. There are also large splinters of very clear sanidine, which might be taken for quartz if they were not biaxial; finally, one observes large cracked crystals of green augite.

As everywhere else in Kerguelen, basaltic rocks occur at Coronet Hill, but here they are not very distinctly characterised. The specimens we class as basalts are scoriaceous, very vesicular, with drawn-out pores; in colour they are deep red, and nothing except lamellæ of black mica can be seen by the naked eye. Under the microscope the ground-mass appears almost opaque from the interposition of a black pigment, with numerous small green crystals of augite, and regular sections of olivine altered into hematite. Large fragments of augite, sometimes enclosing hornblende, also appear.

We have now to describe the rocks of Greenland Harbour. This fjord is situated to the south of Royal Sound, from which it is only separated by a narrow tongue of land. We may first recall the observations made by Mr. Buchanan in this part of the island. On entering Greenland Harbour he was struck by the appearance of the masses of grey rock which rise up boldly from the horizontal beds of basalt. The chain of hills near this fjord is composed of basalt, the greatest mass of grey rock being found on the summits in the western part of Greenland Harbour, and appearing from a distance like a heap of ruins. He was able to examine this rock in two places, at the summit of the hills west of the bay, and near the creek where he landed. He found the rock to be the same on both sides; it is a phonolite of a light greyish green colour, surrounded by basalt. The masses of phonolite are cylindrical and columnar on the outside, the columns being horizontal, and showing a radial arrangement. They do not penetrate the rock, but form a zone some feet thick around the central part, which remains massive. The prisms have been largely disintegrated by weathering, and lie broken up into a great number of blocks around the phonolite masses. The outer portion of the rock, in which the columns are horizontal, resembles a cyclopean wall, and resists atmospheric agencies much better than the solid centre. Were it not for these natural walls binding the whole mass together, the central part would form a

talus of débris as it disintegrated; this the columnar arrangement effectually prevents. The upper part of the most remote phonolitic eminence, which crowns the summit of this chain of hills, rises to more than 50 feet. An accumulation of blocks covering the lower wall is scattered over the steeply inclined slope.

The basaltic rocks, which form the principal mass of the hills, and extend in horizontal layers at Greenland Harbour, as in all other parts of the island, will be described first. The rocks where the Challenger made a landing are altered felspathic basalts, black and massive, displaying no minerals to the unaided eye. The fracture is almost plane. With the lens one sees that they are formed of crystalline grains, amongst which triclinic felspars appear. In the ground-mass composed of microliths of plagioclase and augite are embedded larger crystals of plagioclase, and olivine which has been completely decomposed, only the form remaining; this mineral is replaced by limonite, which also penetrates the whole rock.

The horizontal beds extending to the south-west of Greenland Harbour are formed of a basaltic rock, the porphyritic structure of which is caused by the presence of large crystals of augite, felspar, and olivine. The mass is compact, but the whole rock is penetrated by oxide of iron. Large sections of plagioclase, cracked in all directions, are seen under the microscope. The cracks are filled with opal, and the whole appearance of these felspars resembles those we shall describe in the augite-andesites of Kandavu. Sections of augite and some small crystals of olivine are also seen, the larger ones being so much altered that they are destroyed in polishing the preparations. The ground-mass is formed of a network of small microliths of plagioclase and augite, with some magnetite.

The rock forming the greater part of the hills west of the bay is also spread out in horizontal beds, and, like the preceding, is a basalt, possessing the usual macroscopical character of this rock. Under the microscope this basalt appears with a ground-mass made up of small crystals of plagioclase and augite, and numerous grains of olivine. The most striking feature in these preparations is the great number of large crystals of olivine, which usually are formed of several individuals by direct grouping. These sections are sometimes bounded by curved lines showing the corrosive action of the magma. The olivine is usually decomposed on the edges, where the alteration is indicated by a slightly fibrous yellow border. Augite is less common than olivine, and shows as irregular colourless or pink sections in the preparation. On the edges it takes the same green colour as the small augites of the ground-mass (see fig. 23). These microliths surrounding the microporphyritic sections of augite

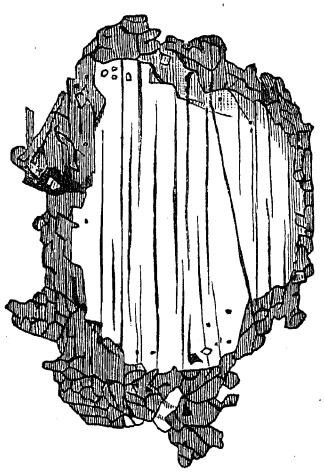


FIG. 23.—Basalt of Greenland Harbour. Section of augite showing the external green zone. $\frac{1}{75}$ crossed nicols.

give rise to this greenish zone. There is no plagioclase to be seen except the microliths of the ground-mass.

Other rocks of a reddish colour and much altered, which were collected by Mr. Buchanan at Greenland Harbour, are also basalts. Microscopic examination shows them to be fine-grained, with a ground-mass of microliths of plagioclase, and grains of augite and magnetic iron. In this are embedded large sections of triclinic felspar, traversed by cracks and in part opalised, like those we shall describe in detail in the notes on Kandavu Island. Augite and olivine also appear as micro-porphyritic elements; the latter mineral particularly is more or less penetrated with oxide of iron.

The horizontally-bedded basalts of which we have been speaking surround grey masses of trachyte and phonolite, projecting above the basalt and having a columnar structure. Their geological disposition and aspect have already been described from Mr. Buchanan's data. These rocks are hard and compact, their colour is greyish green, and although they present marked resemblances to many phonolites, they do not ring, as rocks of this type generally do. Specimens broken off the prisms are finer grained than those from the central mass, and have a distinct cleavage perpendicular to the length of the columns. This rock partially gelatinises in hydrochloric acid; the solution contains much soda and traces of sulphuric acid. From this reaction Mr. Buchanan concluded that these rocks contained at the same time nepheline and nosean. They may be classed as augitic trachytes; in some cases, by the addition of nepheline, they pass into phonolites, and then, finally, when sanidine is absent, pass into nephelinic rocks containing acmite.

We shall first describe the specimens taken from the wall of rock on the summit of the hills lying west of Greenland Harbour. These rocks, projecting above the masses of basalt, are phonolites. They are greenish grey, compact, with a slightly shining fracture and a rather indistinct schistosity. They are sometimes spotted with more or less circular black markings; large crystals of sanidine are to be seen, and sometimes milk-white microscopic sections of nepheline. Microscopic examination shows that the rock is essentially composed of numerous small crystals of nepheline closely packed together, but still preserving the general sharpness of their outlines. This mineral is sometimes seen in larger hexagonal or quadratic sections with zonary structure, standing out from the ground-mass formed by microliths of the same species. Sanidine is comparatively rare, and occurs in elongated lamellæ twinned according to the Carlsbad law. The green mineral is of quite small dimensions, and its outlines are vague; the angle of extinction measured for a great many crystals hardly ever exceeds 15° or 20°, hence the crystals are very probably hornblende. Titanite is

rather common. Fibro-radiated zeolites often occur in the vesicles, and are also disseminated throughout the rock. A specimen of this phonolite has been analysed by Dr. Klement, with the following results:—

I. 1·0730 grammes of substance, dried at 110° C. and fused with the carbonates of soda and potash, gave 0·0387 gramme of water, 0·5887 of silica, 0·2322 of alumina, 0·0461 of ferric oxide, 0·0175 of lime, 0·0110 of magnesium pyrophosphate, and traces of manganese.

II. 1·0285 grammes of substance, treated with hydrofluoric acid, gave 0·2448 gramme of potassium and sodium chlorides, and 0·2130 of potassium chloroplatinate.

III. 1·2168 grammes of substance, treated with hydrofluoric and sulphuric acids in a sealed tube, was titrated with potassium permanganate and required for oxidising the ferrous oxide 2 c.c. of solution (1 c.c. = 0·005405 gramme ferrous oxide).

PERCENTAGE COMPOSITION.

Silica, SiO_2,	54·87
Alumina, Al_2O_3,	21·64
Ferric oxide, Fe_2O_3,	3·31
Ferrous oxide, FeO,	0·89
Manganese,	traces
Lime, CaO,	1·63
Magnesia, MgO,	0·37
Soda, Na_2O,	9·26
Potash, K_2O,	4·02
Water, H_2O,	3·61
	99·60

This analysis confirms the determination of the rock as phonolite, the large percentage of soda corresponding well with the important part taken by nepheline. The water present proves the alteration of the rock, which is also indicated by the zeolites disseminated throughout the whole mass.

Another nepheline rock picked up in the centre of the same creek differs considerably in mineralogical composition from the preceding. It is darker coloured, coarser in grain, marked with opaline points, less schistoid in structure, spotted with small deep green prisms, and sometimes speckled like the phonolite described above. A paler grey-green specimen is very massive, and no mineral can be distinguished by the naked eye; it has a very distinct prismatic fracture. The greyish groundmass is formed exclusively of little crystals of nepheline. In this there appear distinct green lamellar sections which are pleochroic, as it were corroded, and including nepheline crystals. The mineral might be taken for hornblende were it not for its

extinction. Almost all the sections extinguish parallel to their length, and in the case of an oblique extinction it never exceeds 3° or 4°. We consider this mineral to be acmite, the presence of which has been ascertained in rocks analogous to those now described. The outlines of the prismatic zone are fairly clear, but the crystals are corroded, and almost fibrous at the extremities. Terminal faces are never seen, except a rather low dome which is very rare. The pleochroism, as shown by these crystals, is dark green for rays vibrating parallel to c, and yellowish for those perpendicular to that direction (see fig. 24). Like the rocks encircling the creek, this nephelinic mass contains numerous patches of fibro-radiated zeolites.

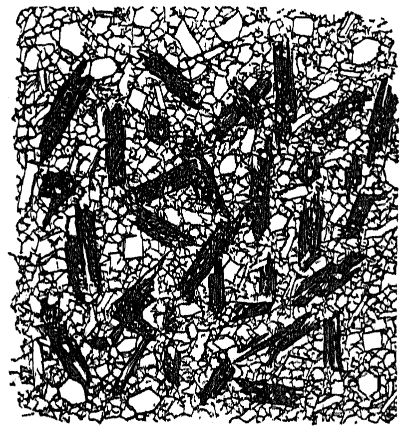


FIG. 24.—Nepheline rock with acmite from Greenland Harbour. The ground-mass is entirely composed of nepheline, numerous hexagonal or quadratic sections of which appear in the figure. In this there are greenish lamellar sections of acmite. $\frac{1}{35}$ crossed nicols.

A specimen taken at the contact of the phonolite and the encasing basalt shows both rocks in juxtaposition, but quite distinct from each other. There is no gradual transition, but a sudden passage from one to the other: on one side the reddish almost spongy basalt, on the other the greenish grey compact phonolite. The latter is brecciated, as if the eruption of the basalt had produced a friction-breccia. The specimens of basalt taken at the contact are in some cases black compact tufas containing lapilli, which are identical in structure and mineralogical constitution with the basalt of Greenland Harbour. Fragments of phonolite are also seen, and sometimes vitreous lapilli altered into palagonite. Amongst the fragments of minerals in this tufa, olivine, augite, triclinic felspars, and large broken crystals of sanidine may be seen. Some of these, especially the plagioclases, are entirely penetrated by silica, which has converted them into pseudomorphs. A group of triclinic felspars is here figured (fig. 25), which shows that they are replaced in the upper part by opal, in the lower by chalcedony. The mass uniting the clastic elements of this tufa seems to be of a vitreous nature, but its characters are vague, and veiled by innumerable opaque grains, most probably of magnetite, which are scattered throughout the substance. The phonolite part of this specimen which is joined to the basalt does not present, from the point of view of micro-structure, anything to distinguish it from

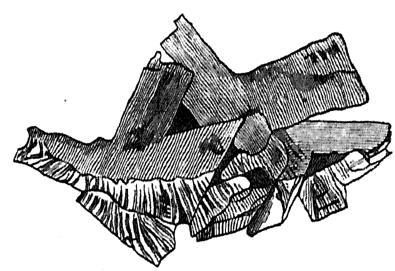


FIG. 25.—Basalt in contact with phonolite from Greenland Harbour.
Group of plagioclase epigenised into opal on the upper part, transformed into chalcedony on the lower. $\frac{1}{20}$ crossed nicols. Polarised light.

the normal phonolites already described, except, perhaps, that the sections of sanidine are somewhat larger.

Another hill situated at this part of Greenland Harbour is formed of a trachytic rock. It is a rounded eminence crowned by a mass of angular blocks, scattered about like the ruins of masonry. The rocks collected here by Mr. Buchanan are augitic trachytes, identically similar to those already described; they were obtained from the bed of a river entering Royal Sound. The rocks are compact, with a slightly greasy lustre, and a subconchoidal fracture. They are bluish grey in colour, sometimes with macroscopic sections of sanidine, sometimes marked with circular black spots, either extended in a zone or combined to form more or less continuous bands. The microscope shows broken crystals of sanidine and microliths of augite grouped round hornblende sections, only traces of which now remain. These augitic microliths combined with grains of magnetite tend to replace the amphibolic mineral, and in some cases do so completely. The sections of these minerals are embedded in a ground-mass formed principally of small lamellæ of sanidine. A specimen of these trachytic rocks from Greenland Harbour has been analysed by Dr. Klement with the following result:—

I. 1·1738 grammes of substance, dried at 110°C. and fused with carbonates of potassium and sodium, gave 0·0188 gramme of water, 0·6835 of silica, 0·2453 of alumina, 0·0065 of ferric oxide, 0·0380 of lime, 0·0126 of magnesium pyrophosphate and traces of manganese.

II. 0·9893 gramme of substance, treated with hydrofluoric acid, gave 0·2069 gramme of chlorides of sodium and potassium, yielding 0·2998 of potassium chloroplatinate.

III. 1·0507 grammes of substance, treated in a sealed tube with hydrofluoric and sulphuric acids, was titrated with potassium permanganate and 3·4 c.c. of solution were required to oxidise the ferrous oxide (1 c.c. = 0·005405 gramme FeO).

PERCENTAGE COMPOSITION.

Silica, SiO_2,	58·23
Alumina, Al_2O_3,	20·90
Ferric oxide, Fe_2O_3,	3·21
Ferrous oxide, FeO,	1·75
Manganese,	traces
Lime, CaO,	3·24
Magnesia, MgO,	0·39
Soda, Na_2O,	6·16
Potash, K_2O,	5·88
Water, H_2O,	1·60
	101·36

This analysis corresponds closely with the average composition of trachytes. The

high proportion of soda may be explained by supposing the sanidine to contain that alkali;[1] possibly also there may be amongst the microliths of the ground-mass little crystals of plagioclase, the determination of which is impossible on account of their small size and their confused arrangement.

Let us now consider what are the stratigraphical relations between these phonolitic masses and the surrounding basalt. According to Mr. Buchanan, no derangement of the beds was found in any case at the contact of the two rocks. He was able to follow the line of contact easily to the highest mass and procure specimens of it. The basalt is much modified for some feet from the line of junction, the large crystals of augite and olivine disappearing near the contact with the phonolite. The line of contact is generally sharp, and many fragments of phonolite are seen enclosed in the immediately bordering basalt, which is very fine grained. The grain grows gradually coarser, until at a distance of 10 feet from the phonolite it reassumes the porphyritic structure which this rock shows in other parts of the island. These two facts seem to show that the phonolite rocks are the most ancient, and that the basalt has been poured out all round them. There is no evidence, on the other hand, that the phonolite has been erupted through the basalt mass.

We shall now describe some rocks from "Foul House Bay," and as this name is not on the chart we cannot follow geographical order in this case. They are coarser grained than the other specimens from the island, dark coloured, with a blackish tinge, and broken surfaces are shining and show a crystalline saccharoid texture. Macroscopical greenish yellow granules of olivine, augite, and plagioclase are seen in it. These rocks present obvious resemblances to certain peridotic diabases or coarse-grained dolerites; their microscopic characters also show the structure and composition of these lithological types. There is no distinct ground-mass, the crystals being entangled. Sections of plagioclase show that this mineral is elongated following the edge P/M, as is usual in the felspars of diabase and dolerite. This plagioclase shows extinctions of 44°, and is thus probably anorthite. Olivine occurs in large sections, rarely with crystallographic outlines, and is sometimes twinned, the two individuals seeming to be united parallel to a pinacoid. This mineral is altered, as is shown by the fissures being lined with an opaque black matter, and the sections penetrated by delessite; no serpentinisation, properly so called, is apparent. Delessite is largely developed in other parts of the rock in question. Large, reddish, zonary patches of augite fill the space between the other minerals. Magnetite or titaniferous iron is very common. Besides delessite, some grains of calcite occur as products of secondary formation. Another specimen, more decomposed, shows the same structure and composition, except that olivine has almost entirely disappeared, its place being

[1] See Roth, Chem. Geol., vol. ii. p. 240.

taken by delessite with the addition of chalcedony, as is often seen in the volcanic products of Kerguelen.

Without knowing the stratigraphic relations of the rocks of Foul House Bay, a summary of the lithological characters of which has just been given, they might be equally well classed as peridotic diabases or recent dolerites, but the probabilities are in favour of the latter supposition.

Taking a summary view of the general observations given in the preceding pages, and those made at Kerguelen by the various naturalists who have explored the island, we see that the physical geography, the disposition, and the nature of the rocks all show the island to be of volcanic origin, and that the eruptive masses of basalt and trachyte belong to recent periods. The basalt formerly spread in vast continuous sheets far beyond the present limits of the land. The oscillations of the land, the erosive action of the atmosphere, of glaciers, and of the waves, have eaten into and carved out the coasts of Kerguelen, thus giving it its actual relief and remarkable outlines.

If we take into account all the observations of British and German naturalists, particularly those of Dr. Studer, it must be admitted that Kerguelen Island has been, in the main, built up by successive eruptions of basaltic masses spread out in wide outflows. At some points as many as twenty of these sheets can be counted one above another. All these basaltic rocks are felspathic, and are associated in a subsidiary way with palagonitic tufas and limburgite; they present great uniformity in structure and composition in all parts of the island. Dolerites appear to predominate, and amygdaloidal rocks with zeolites and geodes of quartz and chalcedony are very common amongst them. All the rocks of this series are connected together by their composition, and the different modes of structure they present may easily be explained. In fact, it is observed that the numerous basalt sheets are fine grained at the bottom and centre, but alveolar or even scoriaceous in the upper part, *i.e.*, the original surface of the stream. This surface is in its turn covered by a more massive rock. It must be admitted that, as in the case of lava-streams, the scoriaceous or amygdaloidal portion corresponds to the upper surface of the lava. Here the expansion of imprisoned gases was not counterbalanced by the pressure of the overlaying rocks, as was the case in the lower parts of the bed. The eruptions have been subaërial, at least in most cases. These facts, so far as they are exhibited in the neighbourhood of the German station, were observed in detail by Dr. Studer, and may be generalised for all other parts of the island; they are shown well at Christmas Harbour.

The terraced structure of these volcanic hills is due to the manner in which the masses composing them were erupted. One might suppose that the successive outflows were superimposed on beds of a former eruption without covering their whole surface,

but it is much more probable that denudation has taken a leading part in the formation of these terraces, the limits of the erosion being determined by the alternations of massive and vesicular structure. We shall see that the surfaces of many of the superimposed layers have been directly exposed to atmospheric agencies, the influence of which has been most powerful on their scoriaceous parts.

The sheets of basalt contain masses of trachyte and phonolite, which are often associated, and form the escarpments crowning the heights of the island. These crests of trachyte or phonolite are shown in Table Mountain, in the region of Betsy Cove, at Royal Sound, and, above all, at Greenland Harbour. The stratigraphic relations of the basalts and trachytes, on which we have insisted in describing Mr. Buchanan's observations as confirmed by Dr. Studer, undoubtedly go to show that the phonolitic and trachytic masses were erupted before the outflow of the basalt sheets. In this connection we may recall an observation of Professor Roth which establishes this order of succession. He found that a trachytic rock from the neighbourhood of Mount Peeper had been exposed to the caustic action of basalt. On the other hand, we have stated that at Greenland Harbour, where basalt and phonolite are found in contact, it is the latter rock that has undergone the mechanical effects of the intrusion, which has formed a true friction-breccia. This necessarily implies the pre-existence of the phonolite.

Taking account, then, of all these observations, it is necessary to admit that in Kerguelen trachyte and phonolite have preceded the basaltic eruptions. There is also sufficient reason for the statement, based on the structure and composition of the trachyte and basaltic series as shown in the island, that their eruption is comprised within the recent volcanic period.

We may also recall the fact that all these rocks, generally altered, are filled with minerals of secondary formation, such as delessite, zeolites, quartz, chalcedony, agate, &c. This greatly complicates the question which must now be put, viz., Are there erupted rocks in Kerguelen which belong to more remote geological periods? Professor Roth and Dr. Studer were inclined to think so. The reasons which led the former to suppose that paleo-volcanic rocks were found there are as follows:—Amongst the specimens from near Mount Crozier he found a micaceous diorite and a fragment of red porphyry, from Lake Margot a labradorite porphyry, and at Winterhafen a rock was picked up which resembled certain dolomites of the crystalline schists. The existence of ancient crystalline rocks in oceanic islands appears incontestable, and we have shown their presence in many of them. Still, in the present state of our knowledge, we think it premature to state positively that outcrops of these ancient rocks exist in Kerguelen.[1] While freely admitting the correctness of Professor Roth's determinations, one may reasonably inquire whether the specimens he examined have not been con-

[1] Mr. Eton says that limestone has been found near Foundry Branch; he adds that Mr. Stone of H.M.S. "Supply" showed him the cast of a fossil shell which a sailor picked up near Thumb Peak; *Phil. Trans.*, vol. clxviii. p. 2.

veyed to the place where they were found by icebergs, or brought up from great depths as enclosures by neo-volcanic eruptive masses. The former hypothesis seems very probable, and is confirmed by taking into account the changes of level which the land has undergone. During the periods of submergence the ice-packs detached from the Antarctic continent and driven towards the north, as at present, may have dropped the rock fragments which they carried. This is not a mere supposition; the Challenger dredgings between Kerguelen and Heard Island have brought up blocks of considerable size, which belong to the crystalline and schisto-crystalline series: granite, diorite, gneiss, &c. No one can doubt that these rocks have been carried by floating ice to the place where they were found, and we may add parenthetically, that they prove the existence of an Antarctic mass of continental land, to which Mr. John Murray has recently directed the attention of geographers. It may possibly be, however, that the fragments viewed as ancient rocks have been carried up by the trachyte and basaltic masses in their passage through the underlying strata. The typical volcanic outflows show many examples of similar facts, but nothing in Professor Roth's description enables one to decide this question. While fully recognising the care which he has taken to establish his diagnoses of the rocks in question, we may yet insist upon the great difficulties in the way of precise differentiation between the ancient and modern crystalline series. These difficulties increase with the amount of alteration of the rocks, and very often it becomes impossible to solve all doubts even with the microscope. Of this no further proof is required than the discussion still going on as to the true basis for a classification of eruptive rocks. This is not the place to carry on a controversy, but, confining ourselves to the subject in hand, we may remark that it is just in the case of rocks like those of Kerguelen, classed as of the ancient series, that the difficulties are greatest. In this way certain granular eruptive masses, which we have described, from Foul House Bay may be equally well classed as peridotic diabases or as dolerites, but their association with basalts gives greater probability to the determination we have thought it right to adopt. However it may be, we must acknowledge that in all the specimens from Kerguelen we have examined, there is not one which can be certainly referred to massive rocks of the ancient type.[1]

The superposition of basalt sheets and their scoriaceous surfaces show plainly that they have accumulated like lava in successive flows. They must have been spread one over another at intervals, this periodicity of the eruptions being shown by the alveolar structure of the surface of the beds. It is evident that if these basalts

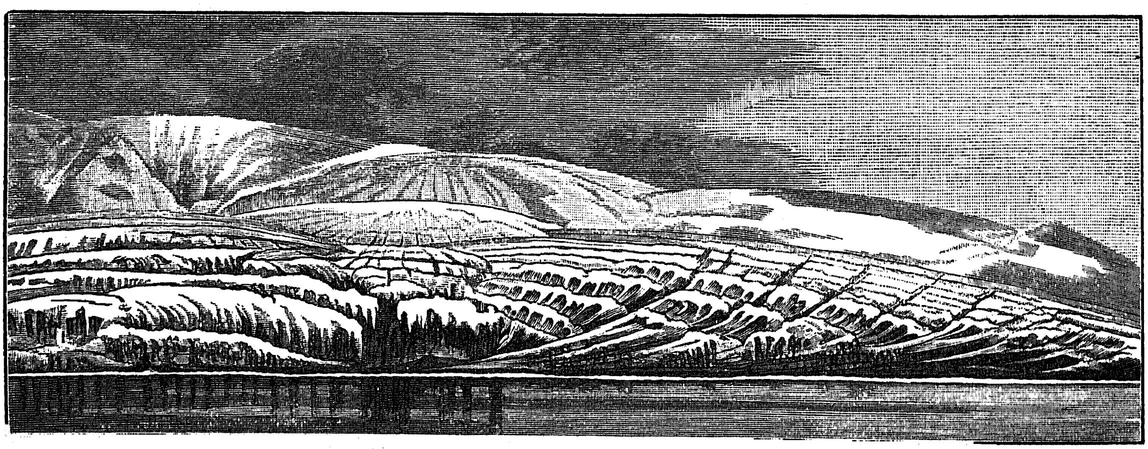
[1] Amongst the rocks from Kerguelen submitted to us there was one without any indication of locality, collected by Mr. Moseley. This at first sight resembles those of the ancient type. The microscope shows a greyish ground-mass very like that of porphyries. Silica predominates in irregular grains, and some sections are similar to altered felspar. It cannot, however, be classed with porphyry, for microscopic examination shows a section of vegetable origin filled with quartz and micaceous substance. Hence we believe this to be a trachytic tufa, the constituent elements of which were bound up with vegetable remains by an infiltration of silica, such as the amygdaloidal rocks of Kerguelen and the fossil woods exhibit so abundantly.

belonged to the same outflow, we should not see an alternation of compact and amygdaloidal rocks. The intercalation of beds of lignite and fossil wood also proves and gives precision to this interpretation. The beds prove that the upper layers of the sheets have been exposed to meteoric agencies, and that, thanks to their scoriaceous structure, they were readily disintegrated and transformed into argillaceous matter, on which vegetation could take root and develop. The growth of large trees proves that there were long intervals of rest between the eruption of the two basalt sheets which enclose these vegetable remains.

Accepting this view of the original arrangement of the basalt sheets, we must consider that Kerguelen formerly presented the aspect of wide basaltic plateaux broken only by escarpments of trachyte and phonolite. It is principally to meteoric agencies that the island owes its present shape. We have said that all the heights of one region come to about the same elevation, and that on both sides of the valleys the various strata occur at the same level. These topographical features show that the hills belonged at one time to a plateau extending over the whole region, and that these hills have been left when the valleys, which cut up and furrow the island, were carved out of the original plateau by running streams, glaciers, and atmospheric agencies. These agents, joining their powers with that of the sea, have formed the fjords and bays which everywhere run into the central mass. These ragged coasts, these cliffs and perpendicular crags and terraced mountains, in a word, the deeply trenched form of Kerguelen, are all explained by the extreme abundance of the atmospheric precipitation which beats on those barren rocks, almost destitute of vegetation. On the other hand, we have seen that glacial phenomena have left their mark everywhere, and added their action to that of running water and of the sea. The oscillations of the land, frequent elevation and subsidence, have also contributed to modify the shape of the island. Everything indicates that these great topographical movements and the epoch of the extension of glaciers have been subsequent to the last outflow of basalt. Finally, we must admit that the causes which have produced the vertical relief and outline of Kerguelen have extended their action beyond the present limits of the island and encircling rocks, and that the central mass is but the remains of a great denuded land. The present configuration shows this, and so does the development of vegetation in earlier periods. As Dr. Studer observes, even if we admit a higher mean temperature in order to explain biological facts, it does not suffice to explain the existence of a flora, for which a much larger land is required, in order to afford protection against the storms that now carry devastation to every part of the island. We are thus led to admit that in times anterior to our epoch Kerguelen was a vast mass of land. The topographical features that we mentioned at the beginning, and the results of soundings made by Ross, and on the "Gazelle" and Challenger, confirm this view, and point to a probable extension towards the south-west.

X.—ROCKS OF HEARD ISLAND.

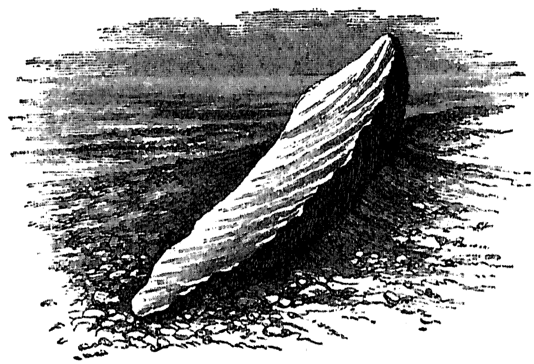
After completing the exploration of Kerguelen's Land, the Challenger Expedition turned to M^cDonald and Heard Islands. The sea-bottom between these groups is very irregular and rocky. On the way to Heard Island the Challenger, on February 5, 1873, passed to the north of the almost inaccessible islands of McDonald. A landing was made on Heard Island, and Mr. Buchanan examined the coast and the rocks descending to the sea. This island, remarkable for its glacial and volcanic phenomena, was discovered in November 1855 by Captain Heard, in command of the United States ship "Oriental." According to the Challenger observations, Cape Laurens, the north-west point of the island, is situated in latitude 53° 2′ 45″ S., longitude 73° 15′ 30″ E.



Glacier, Corinthian Bay, Heard Island, as seen from H.M.S. Challenger.

The greatest length from north-west to south-east is 25 miles, its greatest breadth 9 miles, and its area about 100 square miles. The southern extremity, rising towards the east, forms a long and narrow promontory. The naturalists from the Challenger landed at the north of the island, in a bay designated on the chart as Whisky or Corinthian Bay. On approaching the place to the south-east of the ship the island was surrounded by great glaciers coming down close to the shore; the interior was veiled in clouds, entirely concealing the great mountain of Ben Big, about 7000 feet high, which crowns the island. The shore of Corinthian Bay is flat, and is covered with black volcanic sand, largely composed of magnetite; this sandy strip stretches for about half a mile from the sea to the head of the glaciers. The western side of the bay is formed of a continuous wall of magnificent glaciers. The island here is not wide, and a sandy plain extends across it from east to west. The volcanic sand, blown against the rocks by constant strong winds, gives rise by its mechanical action to remarkable phenomena of disintegration. Mr. Buchanan observed that the fragments of isolated rock, and

glacier-borne erratics, lying on the sand of the shore, were so cleanly sliced by the particles of magnetite and augite, that they seemed to have been chiselled. The largest faces of the blocks on which the erosion has been greatest are always turned to the west, the direction from which the winds are most continuous and strongest.



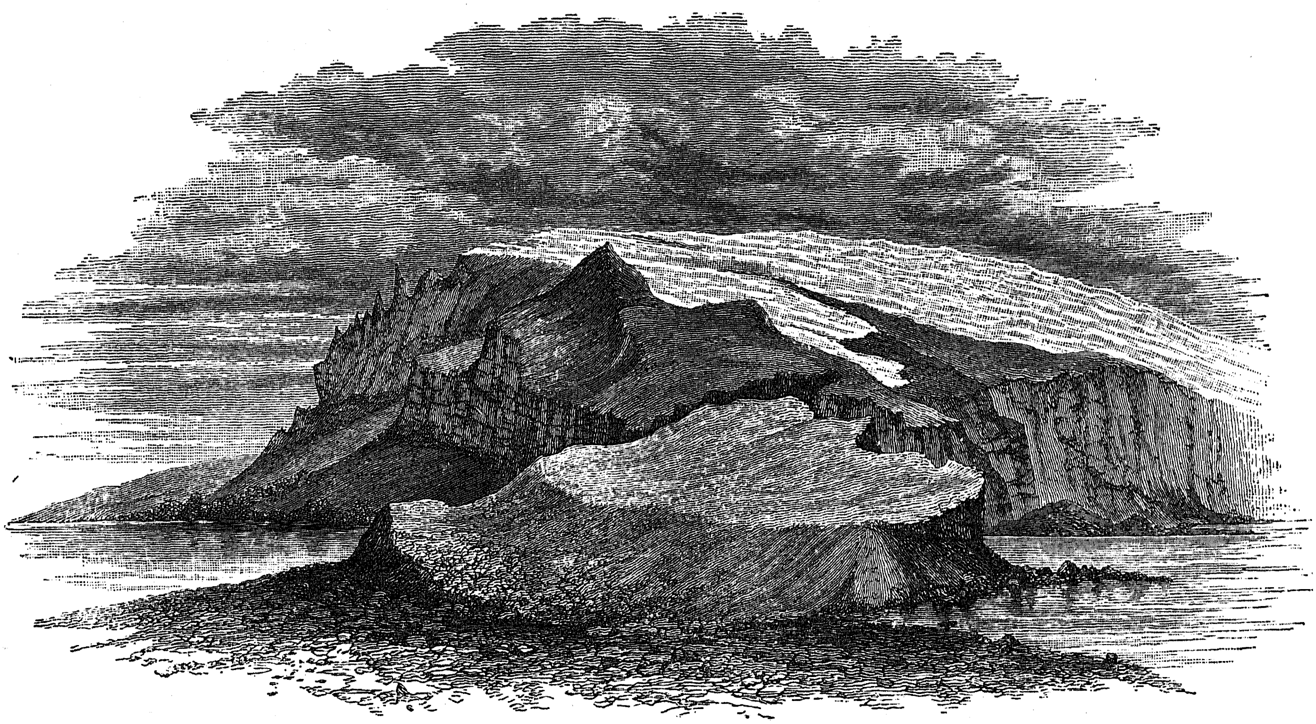
From a sketch by Mr. Buchanan, representing a rock embedded in the black sand. The side towards the west, with the high light on the woodcut, is being rapidly worn down by the sharp sand blown against it, which has cut an irregularly fluted pattern in it.

At the point where a landing was made, two promontories run out; that towards the west is formed of a high mountain rising up from the sea and cleft at the summit into two peaks, from between which a glacier descends to the cliffs on the north-west. Blocks of ice, breaking off, fall into the sea with an echoing roar. The other peninsula is covered with recent lava, the scoriaceous surface of which appears not to have been affected yet by erosive action. The flow extends from the base of a recent but greatly denuded crater, which is worn by wave action into three fantastic peaks, whose vertical walls show the successive lava-flows inclining from the centre outwards. This lava-layer spreads over the whole peninsula, and forms a row of cliffs cut out by wave-action along the northern part of Corinthian Bay. The glaciers covering the southern part have been stopped in their descent to the sea by a conical mound of scoriæ. When account is taken of the slight alteration of its surface, the lava appears relatively recent, and this fact, taken in conjunction with the great energy of denuding agencies at Heard Island, agrees well with the view of an eruption at no distant date.

All the rocks collected in the island are volcanic, and belong to the felspathic basalts. Some are massive, others vesicular; all may be viewed as derived from the lava-sheets which have spread over the island.

We shall first describe those specimens collected to the south-west of the solitary group of houses on the islands. In this place the rocks are spread out in beds, and present to the naked eye all the appearance of basalt, being black and fine-grained, with only olivine perceptible amongst the constituent minerals. Microscopically the rock is at once classed as a felspathic basalt, the minerals of the first generation being plagioclase,

olivine, augite, and rather large grains of magnetite, embedded in a ground-mass of minute plagioclase and augite microliths and a vitreous base. The plagioclase sections have very sharp outlines, and can thus be determined with a precision rarely attained in the study of rocks of this nature. It is at once apparent that the plagioclase crystals occur habitually in groups of several, united more or less regularly, often parallel to *M*, and presenting all the peculiarities of certain macroscopic crystals of albite, those of Schmirn, for example, and of some crystals of labradorite. In many cases the sections of plagioclase have the form of a nearly rectangular parallelogram, with polysynthetic twins and symmetrical extinction; these sections are thus in the zone $P:k$, and, since



From a sketch by Mr. Buchanan, representing the mountainous promontory forming the north-western end of the island. The top of the mountain was enveloped in cloud, below which the greater part of its sides were covered by a glacier descending to the edge of the precipitous rock cliffs, over which the ice-masses fell thundering. The sketch was taken from the shoulder of a red conical hill, against which the ice, descending from the main mountain of the island to the sea, splits and passes on both sides of it.

they are approximately at right angles, we may conclude that the crystals are tabular, and terminated only by the faces of this zone. Sometimes, but more rarely, plagioclase sections are observed bounded on one side by angles of about 90°, and on the other by more or less obtuse angles formed by the trace of two edges, which may correspond to *T* and *l*, and are in general but slightly developed. The sections parallel to *M* enable the form of the crystals to be ascertained, and the optical properties determined. Sections parallel to this face appear as sharply outlined disymmetrical hexagons, which

are bounded by traces of the faces *PyT*. That this is the case, is ascertained by the measurement of the angles and the direction of the cleavages, the latter exhibiting a line of cleavage parallel to *P*, and another, but less pronounced system, parallel to the prism. The angle of intersection of the trace of *P* and of the trace of the adjacent face is about 100°; this face is therefore *y*. The other side of the section makes an angle of about 64° with the trace of *P*, and is therefore *T*. The extinction for the section in question is negative, and takes place at 27°. The felspar accordingly approaches to bytownite. These observations have been made on a great number of sections of the rock, and each time the angular values were approximately the same. The symmetrical extinction of the sections showing albitic twins was about 40°; this value is another proof of the exactness of our determinations. The plagioclase has almost always crystallised according to the albite law, sometimes associated with that of the Carlsbad type. In some cases, also, this plagioclase is twinned according to the Baveno law. Thus two crystals of plagioclase, both twinned according to the albite law, can be observed grouped in such a way that the traces of *M* in the two individuals make an angle of about 90°. The extinction of the albitic striæ is the same for the two crystals, being about 40°, from which we may conclude that the section has been cut for both of the adjacent individuals in the zone $P:k$, and the fact that the extinction of the albitic lamellæ is the same in both confirms the supposition that they have a plane of this zone in common. The angular value of the extinction seems also to indicate that the section is approximately perpendicular to the edge P/M. The facts we have just mentioned thus prove the existence of the Baveno twin in some crystals of this rock, and that of pericline has also been demonstrated. Many of the plagioclastic sections show a zonary structure, especially those cut parallel to *M*, on which are observed a series of concentric zones, the inner ones being disymmetric hexagons, the outer quadrangular, representing traces of the faces *Py*. Thus the internal hexagonal zones show supplementary traces of *T*. At the beginning of their growth the plagioclases crystallised with the faces of the prism, which became smaller in proportion as the crystals formed, and finally disappeared when the last layers were deposited on the nucleus. This fact may be generalised and applied to all the plagioclases in the rock, as the prismatic faces are wanting in the greater number of crystals, or, if they are present, they play a very subordinate part.

In this basalt the felspar sections often show alterations due to the action of the magma; the angles are rounded off, the crystals often corroded, and penetrated by the vitreous mass in which they are embedded. We cannot, however, explain, by subsequent modifications, certain optical phenomena resembling the undulating extinction. At first sight one is tempted to ascribe these to the result of strain exerted on crystals already formed. But they are explained by the manner in which the hemitropic lamellæ are entangled. When observed in polarised light, a good many sections are

seen to be traversed by black lines, with shaded borders, showing a certain parallelism. In other cases, when the section is turned round between crossed nicols, shadows are seen sweeping across. The difference between this appearance and that of undulating extinction does not appear at first, but, as we have just said, pressure cannot be called in, in this case. These phenomena are never seen in sections which show hemitropic striæ with great sharpness, nor in sections parallel to M. Sections of an intermediate zone, approaching M, show this peculiar extinction; on the other hand, when the sections are more in the zone $P:k$, the parallel black lines with shadowy borders appear. These observations lead us to conclude that this extinction is due to the fine lamellation of this plagioclase, the sections of which, cut more or less obliquely to the plane of twinning, must in polarised light show these undulations, or these traces of albitic lamellæ with indistinct borders. Olivine is somewhat uncommon in this basalt; it usually appears in grains, but occasionally the sections present crystallographic outlines. Amongst the latter there is one form which is hexagonal, with two parallel sides longer than the others. In ordinary light it appears quite homogeneous, but in polarised light it is seen to be divided into halves by a straight line perpendicular to the longer sides. The two halves in certain positions between crossed nicols show sharply different colours, although these are not very intense on account of the section being cut perpendicular to an optical axis. In convergent light this axis is shown to have the same position for the two halves, and to be eccentric. Everything indicates, however, that the plane of the optical axes is perpendicular to the direction indicated in the section by the trace of ∞P, which corresponds to the longer sides of the hexagon. The shorter sides should be traces of flattened domes. This section shows two cleavages: one parallel to the base, the other parallel to a pinacoid of the prismatic zone, and perpendicular to the former. More or less irregular fractures may also be observed parallel to the short sides of the hexagon, indicating a less distinct cleavage following the faces of flattened domes. The sections of olivine, sometimes little altered, are crowded with inclusions of magnetite.

The augite presents no noteworthy peculiarity, except that the crystals are often grouped. They are sometimes twinned in the ordinary way, or intercrossed with considerable regularity, although not clearly enough to show a law of twinning.

The ground-mass is chiefly composed of microliths of augite and plagioclase—the latter lamellar and giving great extinctions—and of a vitreous base, which surrounds all the minerals of the rock.

Another specimen from the same place closely resembles that just described, except that the colour is greyish, and rather large crystals of augite are visible to the naked eye. The microscope shows that it also is a felspathic basalt.

Finally, rocks from the same locality have a scoriaceous structure; they are black, and contain somewhat large vesicles. The ground-mass appears compact and fine-

grained, but is sometimes altered on the surface, assuming a reddish colour, and is impregnated with limonite. Microscopic examination shows that, like the other rocks, it is a felspathic basalt. Rather large sections of augite and olivine predominate in the ground-mass, which also contains small microliths of plagioclase and of augite, with magnetite, and a vitreous base. The felspars do not attain the dimensions of porphyritic elements, and this rock presents few noteworthy peculiarities, except those due to the alteration of olivine. The sections of this mineral are, as a rule, partly filled with trichites; the spots not yet occupied by this secondary product appear clear and limpid, but in polarised light these apparently unaltered portions hardly show the colours of chromatic polarisation. We remark also that not only is the mineral full of trichites, but that while its external form remained unchanged, it was permeated by a secondary product, part of the original substance being removed. The mineral which has formed in the interior of the sections appears as groups of prismatic crystals, the summits directed towards the centre and the bases attached to the outer margins. These microliths are arranged in parallel bundles, and appear at first sight to be felspar, especially considering that we can detect in the same rock small plagioclases of undoubted secondary origin filling up cracks. Still it seems impossible to reconcile this interpretation with the crystalline forms and with the absence of polysynthetic twins, no traces of which are to be found in the prisms included in the olivine sections. The microliths in question present flattened angles at the summit, which may even appear like a terminal pinacoid. From this form, and the fact that extinction takes place almost parallel to the length, the microliths resemble certain zeolites, such as desmine and natrolite. They cannot be ascribed to the zeolites, however, for their outlines stand out too clearly, and the polarisation colours are identical, we may say, with those of the felspar microliths of the ground-mass. They might be identified perhaps with pilite. Olivine often forms in this rock very elongated crystals, which have sometimes been broken by movements of the magma.

A rock which is also scoriaceous, but contains better developed crystalline constituents, approximates in its texture to dolerite. Microscopic examination shows certain details in the structure of the plagioclase crystals which are worth noting. The sections not showing polysynthetic lamellæ are never perfectly homogeneous. They are speckled with more or less rectangular points, all of which extinguish simultaneously, and are similarly oriented. These inclusions are not isolated, as they seem, but must be united by a layer of slight thickness extending under the plane of the section. This is proved by the examination of sections of the zone $P:k$, in which polysynthetic twins appear. The polysynthetic lamellæ are not continuous, but interrupted at a certain distance, and the space left free is filled by the principal individual. Thus a section parallel to M ought to show these lamellæ in the form of quadratic inclusions; they ought to present different extinctions from the felspathic mass formed of the principal

individual, and show themselves in the manner we have described. The sections of augite and olivine are in no way remarkable, except in being often corroded by the magma. Augite frequently occurs as inclusion in plagioclase. We may also mention, amongst the constituents of the rock, grains and crystals of magnetite, and a rounded fragment of hornblende surrounded by a large zone of magnetite.

Layers of volcanic conglomerate were observed near the fishermen's huts. The microscope showed this rock to be made up of basaltic lapilli, and more or less fragmentary minerals, with rather vague outlines, embedded in a light greenish mass. In the yellowish vitreous lapilli there are microliths of augite and small crystals of olivine. Plagioclase is not so common as the former minerals, but appears sometimes in the form of skeletons forked at both extremities.

A limburgite coming from the bed of a river in Corinthian Bay deserves description. This rock is greyish black, and the constituents are large enough to be recognised by the naked eye as crystalline grains of olivine and augite. The microscope proves the absence of felspar, and shows the ground-mass to be a brownish glass, enclosing crystals of olivine and augite. The forms assumed by olivine in this rock may be deduced from the microscopic sections. The hexagonal sections prove the existence of faces of the prismatic zone surmounted by a face of a sharply pointed dome. The angle between the traces of the dome is from 79° to 80°, and the value of k/k is 80° 53′. The sections are grooved with cleavages at right angles, parallel to the outlines of traces of the prism and to the base. The form of sections with a reëntrant angle shows that the olivine is often formed by juxtaposition of a certain number of crystals with parallel axes. They are often corroded by the magma. The examination of this rock tends to confirm an observation often made before in limburgites, that the best developed element in this lithological type is olivine; the augite is often in the form of microliths embedded in the vitreous mass. Another specimen of limburgite from Corinthian Bay, identical in composition and texture with the preceding, is somewhat rich in zeolites, as this kind of rock nearly always is.

The cliffs of the island contain layers of more ancient eruption. We have examined some specimens of these; they are greyer in colour and less scoriaceous in appearance than the rock last described. In one fine-grained mass the lens showed the felspathic element to predominate over the other constituents, and this was confirmed by microscopic examination. This rock is a basalt like all those of Marion Island. Microscopic preparations show large irregular or rounded sections of olivine and very numerous lamellar plagioclases, between which are embedded small irregular grains of augite. Magnetite occurs between the other constituents, and there are also a few small scales of biotite.

XI.—ROCKS OF KANDAVU, FIJI ISLANDS.

A paper by Professor Wichmann[1] has already made known a good many rocks collected in the Fiji archipelago by the naturalists of the Godeffroy Museum in Hamburg. He has shown that the whole series of paleo-volcanic rocks are present in these islands.[2] The more recent are especially represented by basalts and andesites. The latter, associated with fossiliferous volcanic tufas of tertiary age, compose by themselves almost all the small islands of the archipelago. According to the same author, the volcanic products of Kandavu are andesites. Professor Wichmann described some specimens taken from Mount Washington or Buke-Levu, which rises at the western extremity of Kandavu. Those about to be described came from a point to the north of the port of the island, where they were collected in August 1874 by the staff of the Challenger. All that is known about the geological nature of Kandavu is that the greater part of the island is a volcanic conglomerate of coarse structure, in which large blocks of lava are embedded. The island is covered with rounded hillocks, rising tier above tier. Mr. Moseley explains the regularity in form to the action of denudation. We may add that in Ovalau, the nearest island to Kandavu, the appearance is similar, and the rocks seem to be of the same nature.[3] According to Mr. Buchanan, all the rocks we are about to describe crop out near the port of Kandavu, and show a columnar structure.

We shall first describe those belonging to the amphibolic andesites. The naked eye distinguishes in a greyish ground-mass rather large, whitish, vitreous sections of plagioclase, and black specks of hornblende or biotite. The rock is rough to the

[1] Beitrag zur Petrographie des Viti Archipels, *Min. pet. Mitth.*, Bd. v. pp. 1–60.

[2] It seems advisable to point out here, in connection with Professor Wichmann's paper, such geological details of the archipelago as we are acquainted with. Meinicke (Die Inseln des Stillen Oceans, p. 2, Leipzig, 1876) has summarised the mineralogical observations made on the Fiji Islands by Gräffe, Macdonald, Seemann, &c., and we may refer also to Horne (A Year in Fiji, pp. 163–170, London, 1881). According to these authors, the most abundant rocks are argillaceous and calcareous, also breccias and conglomerates, and in some places sandstone and clay slates, while basalts and trachytes form the highest summits, and more recent sedimentary rocks are deposited on the slopes. The island of Taviuni is the only one in the group which is exclusively volcanic, and this, according to Horne, is the only one of subaërial formation. But Professor Wichmann observes that the absence of tufas or of other rocks on the declivities of Buke-Levu in Kandavu seem to show that this island is not altogether of submarine origin. The rocks collected in Fiji by Gräffe (1862 and 1865), and by Kleinschmidt (1876–1878), showed that crystalline and schisto-crystalline rocks of the ancient series played a considerable part in Buke-Levu. The fossiliferous rocks there are of tertiary age. All the other islands visited by the explorers were found to be composed of andesites and basalts, and of tufas of these two lithological types. In some of them coral limestone, sometimes silicified, has been found. All these observations lead to the opinion that in the palæozoic and mesozoic epochs this archipelago formed a continent which became submerged about the middle of the tertiary period. Professor Wichmann made it evident that the data furnished by the study of the rocks of the Fiji archipelago present a great analogy from this point of view with those resulting from the examination of other Pacific islands. Contrary to the general opinion, held until very recently, that all the Pacific islands were of volcanic formation, it is now proved that several of them are built up of ancient crystalline and sedimentary rocks. In his paper on the rocks of the Fiji archipelago, Professor Wichmann has established very clearly the facts on which he founds this interpretation (see *loc. cit.*, pp. 1–8).

[3] Moseley, Notes of a Naturalist on board the Challenger, p. 301.

touch, and has a very irregular fracture. The microscope shows the ground-mass to be composed of a light yellowish or almost colourless base containing numerous felspathic and augitic microliths, and granules of magnetite. Brownish transparent scales of biotite are sometimes found.

The crystals of plagioclase are usually zonary, and twinned according to the albite and Carlsbad laws; they are generally formed of two large individuals enclosing a few extremely thin hemitropic lamellæ. In some cases one of the principal components, twinned following the Carlsbad law, is polysynthetic, while the other is simple, and presents traces of cleavages crossing at 90°. The outlines of those crystals, which are characterised by the rarity of hemitropic lamellæ, exhibit a face equally inclined to the traces of P and of M, which may correspond to a dome of the zone $P:M$ (n or c). Its trace makes an angle of about 45° with the traces of M and of P. That this plagioclase is a Carlsbad twin may be proved by the fact that in those sections where only the two principal individuals are seen, the projection of the vertical faces appears in an opposite direction in the two crystals; these twinned individuals have asymmetrical extinctions: one darkens at about 40° from the trace of M, and the other at 22°. The latter observation also proves that the plagioclase is a Carlsbad twin and is allied to labradorite. In the zone $P:k$ the angle of extinction for two adjacent plagioclastic lamellæ has been found to be from 17° to 20°, which confirms that this plagioclase is a mixture allied to labradorite. The sections of plagioclase often exhibit reëntrant angles, which in ordinary light are apt to be mistaken for indications of twinning, but examination between crossed nicols shows that the crystals are simply grouped without hemitropy, being united with parallel axes.

Hornblende plays an important part in this andesite. It has not only crystallised with the faces of the prism, but the two vertical pinacoids are often represented, and one of them even rather well developed. This mineral is frequently altered and surrounded by a black zone of magnetite; in other cases it is bordered by an aggregation of small prisms, which are also contained in the centre of the sections. This bacillary aggregate must be considered of secondary formation; the small prisms composing it are united parallel to their length, they are crossed by cracks parallel to the base, and are almost colourless, or exhibit a greenish tint. It is not easy to measure the extinction, but when this could be done it was found to be about 40°. Possibly this aggregation may be made up of small prisms of augite. They are arranged in such a way as to show a parallelism between their long axis and that of hornblende, and seem to behave almost like the fibrous hornblende which surrounds augite passing to uralite; here this paramorphosis appears to be reversed. The alteration of hornblende becomes visible not only by the zone of magnetite, or the surrounding groups of augite microliths just described, but it is accompanied by a development of biotite in the heart of the mineral. The manner in which this

pseudomorphism is effected is as follows. The hornblende becomes darker in colour, the pleochroism more intense, the polarisation tints approach to dark-red tones, and the sections assume a lamellar texture, the lamellæ appearing undulated on the surface in polarised light. In fact we see all the characters of hornblende being exchanged for those we are accustomed to associate with black mica, but the form of the sections is unaltered. We shall show immediately, that biotite exists as a primary mineral in the rocks of Kandavu, and must point out the peculiarities which make it possible to distinguish this from the secondary product just described. In some cases the form of the sections gives no assistance, because both hornblende and black mica may appear in thin slices as hexagonal sections. Yet it is possible to demonstrate the secondary origin of the biotite, for, when this is the case, its hexagonal sections show lamellæ parallel to one of the sides of the hexagon; an observation sufficient to prove that the biotite is of secondary formation. A hexagonal section of biotite could not present this appearance; the lamellæ would not show themselves, and the section would appear uniform. Those lines which appear in the sections, and are caused by the union of lamellæ of biotite, cannot be mistaken for the cleavages of hornblende. Even if the characters of the mica were not so clear, this supposition could not be reconciled either with the outlines or with the direction of the supposed cleavages. The observations tend to prove that the lamellæ of biotite are piled up parallel to one of the pinacoids of the hornblende.

There is little to say of biotite as a primary mineral. At first sight it closely resembles hornblende, being surrounded, like the latter, by a black opaque zone; but its pleochroism, its pronounced lamellar structure, its reddish polarisation colours, its brilliant tints between crossed nicols, and the characteristic undulating shades on the surface of the section, prevent one from confounding this mica with anything else. It is recognised as a primary mineral by its sharp outlines, either hexagonal or in the form of a parallelogram, and by its always appearing isolated in the ground-mass.

Augite is rather uncommon; some microporphyritic sections of the mineral are of a green colour, such as it often assumes in andesites. Bronzite is of more common occurrence than monoclinic pyroxene. Olivine appears only in one of the specimens from Kandavu which were examined, where it is an accessory element. Its sections were of the usual rhombic or hexagonal form with worn outlines. It is a hyalosiderite converted into hematite, and full of trichites.

One of the specimens from Kandavu is an augite-andesite. It is a coarse-grained rock, showing to the naked eye a greyish paste, enclosing crystals of plagioclase, from 2 to 3 millimetres in diameter, and small grains of greenish augite, with a few points of black hornblende. Under the microscope this rock differs from that previously described by the predominance of a vitreous base and the presence of microporphyritic crystals larger than those of the amphibolic andesite just mentioned. Hornblende

plays only a subordinate part, being substituted by augite. The microliths in the glassy base are not so numerous, but of the same species as in the preceding rocks.

Numerous and well-defined plagioclase sections are full of vitreous inclusions. Some of them show simultaneously the twinnings of pericline and of Baveno; that of albite is subordinate. The two series of polysynthetic lamellæ, which correspond in the principal individuals, cross at an angle of about 90°. The albitic striæ extinguish at 30°, a fact which indicates that we have to do with a mixture approximating to labradorite. When the sections present the lamellæ of pericline clearly defined, the extinctions for the latter are a little smaller than for the principal individual, being about 27° for the lamellæ in question and 30° to 31° for the polysynthetic lamellæ twinned following the albite law (see fig. 26).

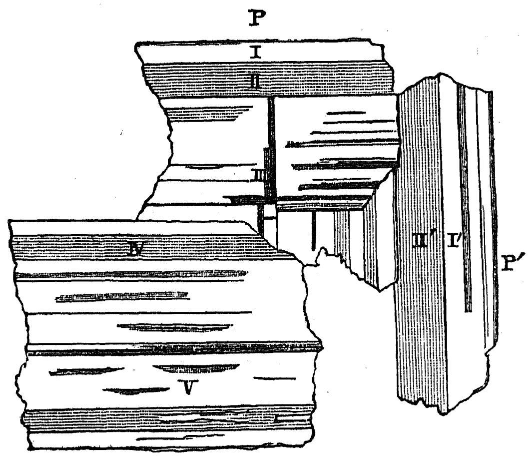


Fig. 26.—Augite-andesite of Kandavŭ. Section of twinned plagioclase.

I. II. . . . Pericline twin.
I.′ II.″ . . . do.
(I. II.) (I.′ II.″) Baveno twin.
III. I. . . . Pericline twin.
IV. V. . . . Twinned with I. and II. having the face *P* common.

The augite presents its usual characters in augitic andesites. It is sometimes twinned polysynthetically; in other cases the sections show a fibrous structure causing them to resemble diallage. Augite contains felspar and magnetite as inclusions. Hornblende, which has a very small part to play in this rock, is represented by sections often twinned, with worn angles and surrounded by magnetite. The pleochroism of this hornblende is—

γ	>	β	>	α
yellow-brown.		brownish yellow.		pale yellow.

XII.—THE VOLCANO OF GOONONG API (BANDA ISLANDS).

The whole Banda group, comprising twelve islands, with a total area of about 18 square miles, is of igneous origin. Volcanic activity is now concentrated in one of the two islets which protect the port of Great Banda on the north-west of the island. This volcano, Goonong Api (Malay=Fire Mountain), has been long known. The first recorded eruption took place as far back as 1629; another followed in 1690, when Goonong Api entered on a state of activity which lasted five years; and then followed the eruptions of 1765, 1775, 1816, 1820, and 1825. In November 1825 the eruptions were accompanied by earthquakes which ruined Great Banda and the islet of Pulo Neira.

The naturalists of the Challenger explored Goonong Api towards the end of September 1874, and observed a great number of facts, which will be summarised before commencing the description of the eruptive products collected up to the very summit of the volcano.[1] The mountain rises in a conical form to 1860 feet above sea-level. Neither the Dutch residents nor the native Malays attempt to scale the rugged heights save on rare occasions. M. Bickmore, one of the first to climb the mountain, has described his expedition, probably exaggerating the dangers of the ascent; the Challenger's staff, in order to study volcanic activity in the crater itself, climbed the volcano by the eastern slope. Up to within 700 or 800 feet of the summit the ground was covered with brushwood, which gave something to hold on by, and rendered the ascent, if not easy, at least practicable. On passing the upper limit of vegetation the naturalists came upon a vast accumulation of loose blocks, which rose up like a wall before them, and gave way when stepped upon. Above these heaps of broken stones the ground was firmer, the blocks of lava and volcanic ashes forming a solid foothold, but sharp angular pieces of lava piercing the bed of ashes made even this part of the cone troublesome to climb.

Exhalations of acid vapours escaped from all the cracks on the summit, and acted energetically on the lava, which was in some places entirely transformed superficially into a white substance looking like chalk. This action of the fumaroles is frequently confined to the outside of the rock, the interior preserving its fresh appearance almost unimpaired. The escaping vapours had a temperature of 121° C.; they were acid, and had a strong sulphurous smell.[2]

[1] See Moseley, Notes of a Naturalist &c., p. 382; and *Narr. Chall. Exp.*, vol. i. p. 561.

[2] Reference will be made, in describing the volcano of Camiguin, to the high temperature at which algæ live in warm springs escaping from crevices in the lava. Analogous observations were made on Goonong Api; gelatinous masses made up of algæ were found attached round the mouths from which jets of vapour escaped. The vapour had a temperature of 121° C., and the plants were fixed to the rock where the thermometer marked 60° C. In a crack of the lava whence a sulphurous emanation escaped a plant was growing in a soil at a temperature of 38°; a foot and a half from this point the temperature of the rock was 104° C.

On the shore of the island, at the foot of the volcano, there is a girdle of coral easily accessible at low tide. The polyps are fixed to the volcanic rock, and the top of the bank rises a foot above sea-level. The island has thus at a comparatively recent period been subject to oscillations such as may be expected in a volcanic region. After these brief remarks on the geological phenomena of Goonong Api we shall describe the lithological characters of the eruptive products collected on the top of the volcano.

We shall begin with the less decomposed lavas, and afterwards deal with those which show in their altered appearance traces of the action of the acid vapours to which they have been exposed. All these rocks belong to the type of augitic andesites.

Some very slightly decomposed lavas are black, very lustrous, slightly scoriaceous, and spotted with felspathic grains. Microscopically they are formed of a yellowish base crowded with microliths of plagioclase and augite, and in this ground-mass are seen rather large sections of plagioclase, augite, magnetite, and, as an accessory mineral, olivine.

The microporphyritic crystals of plagioclase, which are vitreous, like sanidine, are sharply outlined, and are elongated following the edge, *P*/*M*, but in other cases they are less tabular, assuming the prismatic form. The most common types of twinning of these plagioclases are those of Baveno and of albite, but the hemitropic lamellæ are not numerous in the sections. The felspar sections often present the appearance of two halves joined together, resembling at first glance a Carlsbad twin, but closer examination almost always shows one or two hemitropic lamellæ—sometimes excessively thin—enclosed in one or other of the principal individuals. These striæ prove that this felspar is plagioclase. Fig. 27 shows a section of plagioclase from the rock we are describing. The section is parallel to the face *M* of one individual (I) and more or less parallel to the face *P* (zone *P*:*k*) of the other (II). It can be seen that (I) is traversed by cleavages parallel to *P*, which are parallel to the plane of union and to the plagioclastic striæ of (II). Cleavages parallel to *T* can also be seen. The angle of extinction approaches 40°. The individual (II) exhibits less regular fractures, resembling those usually seen in sanidine. It is noticeable that, as is almost always the case, only one of the cleavages following the prism is to be seen. The angle of extinction for the principal individual, measured from the intercalated polysynthetic lamellæ, is about 30°. The extinctions on *M* and *P* exceed those of bytownite, and are nearer to those of anorthite. The extinctions

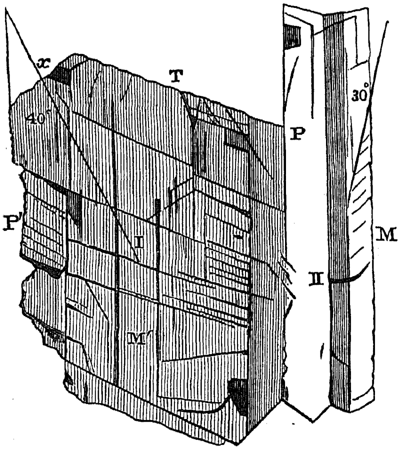


FIG. 27.—Decomposed lava of Goonong Api. Section of plagioclase.

observed between two hemitropic lamellæ in the zone $P:k$ are 32°, 21°, 19°, but in some cases they exceed 35°. These values agree with the determination just given. We see another confirmation of this in the fact mentioned above, of the rarity of hemitropic plagioclastic striæ; it is well known that the extremes of the plagioclastic mixtures, albite and anorthite, are to a certain extent characterised by the rarity of these interpositions, or by the relative thickness of the hemitropic lamellæ.

The augite presents no very special characters; it exhibits a tendency to form more or less irregular groups or nests, and is often twinned. The very rare sections of olivine, often occurring as inclusions in the plagioclase, are decomposed into red hematite. Magnetite is somewhat abundant. The microliths of the ground-mass, as observed above, are small crystals of plagioclase and augite, the former being often split up at the extremities.

The remaining rocks from the summit of Goonong Api have been altered by the action of fumaroles, as in the case of certain lavas from Ternate, but in those from Goonong Api decomposition is further advanced, and presents some phenomena worth describing. These lavas have the same aspect and the same lithological constitution as those just described, only they are much more friable, and covered in some places by a floury coating. One sees with the lens that the felspar crystals have lost their glassy lustre and appear porcellanous. Under the microscope the large sections of felspar show hardly any remaining trace of the original twinning, but their outlines are maintained notwithstanding the alteration that has destroyed the internal structure of the mineral. The sections are furrowed with a lacework of cracks lined with a colourless substance, in the same way as serpentinisation penetrates olivine. A few patches of the original mineral remain unaltered, but as a rule the entire section behaves between crossed nicols like an isotropic substance. The plagioclastic sections invaded by this secondary product rarely show the twins of plagioclase, one can only detect certain remains that react feebly with polarised light. These crystals often appear cracked (see fig. 28). The first explanation that offers itself to account for this strange phenomenon of decomposition is that the rock, being formed of anorthite—a plagioclase which lends itself very readily to the formation of zeolites—the alteration of the felspar would be due to a modification of this kind; but chemical analysis proves that the substance penetrating the felspar is silica. In fact, the undecomposed augite-andesites of Goonong Api contain from 55 to 59 per cent. of silica, and when they exhibit the alteration which has been described the percentage of silica rises to 80 per cent., and, in the specimens trans-

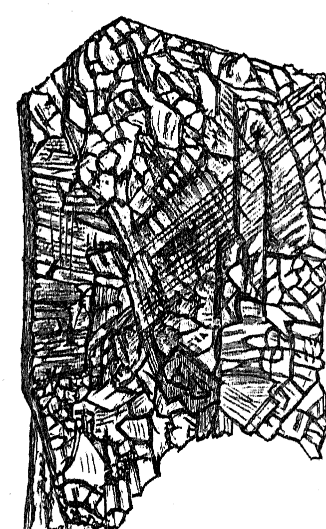


FIG. 28.—Lava of Goonong Api. Decomposed plagioclase partly replaced by silica.

formed into white material, it may even amount to 90 per cent. The substance which fills the crystals of plagioclase in this rock is thus silica. The augite sections even have not escaped this alteration; their margins appear corroded; a zone of silica, like that which we have observed in the felspars, surrounds them as with a frame, and sends ramifications through the crystals until, in many cases, the augite is transformed into a greyish isotropic mass. The augite can only be recognised by its external form, which is generally preserved, or by greenish or brownish fragments entirely embedded in silica. The vitreous ground-mass itself is subject to a similar modification in some cases, its usual yellow colour passing into grey. The outlines of the microliths are made indistinguishable, except perhaps in the case of magnetite, and all the constituent minerals seem to be embedded in the opaline mass. The siliceous matter rarely assumes the form of quartz, but here, as at Ternate, granules are sometimes seen possessing the optical properties of that mineral, or of tridymite. Quartz or tridymite is detected most frequently in the fragments covered with a coating of more or less powdery white material.

The alteration and displacement of these minerals by siliceous matter must be caused by the action of gaseous volcanic emanations, by jets of steam, and by high temperature. Amongst the vapours which attack silicates most energetically are those of hydrochloric and sulphuric acid. The latter, detected in the fumaroles of Goonong Api, can easily remove all the bases of this lava as soluble sulphates, which would readily be washed away. This is the case with the alumina and iron, while the silica, with which they were combined in the eruptive rocks, remains alone in the form of hydrate.

The alteration of felspar and augite into a substance resembling opal is a fact observed elsewhere. We may refer, for instance, to the investigations of Rammelsberg[1] on the pyroxene of Vesuvius in the lava of 1852, in which the amount of silica reached 85·34 per cent.; water was present to the extent of 5·47 per cent.; the mineral which had been altered by the action of fumaroles contained only traces of bases. Morawski and Schinnerer[2] showed that the sanidine of the trachyte from a solfatara near Pouzzolie contained 90·19 per cent. of silica and 4·19 per cent. of water. According to Blum,[3] the sanidine of Furnas is similarly changed into opal, the surface of the crystals remaining hard, while the interior is cellular and porous. Finally, Fritsch and Reiss[4] found the same modification in the felspar of a phonolitic rock of Pico de Teyde. These facts bear the most perfect analogy to those we have been describing, and they should be attributed to the same cause. The presence of quartz and tridymite, which were detected in some of the altered rocks, may be explained by their formation as products of sublimation, a mode of origin for these minerals too well known to require to be discussed here.

[1] Rammelsberg, *Pogg. Ann.*, Bd. xlix. p. 388.
[2] Morawski and Schinnerer, Verh. geol. Reichsanstalt, p. 161, 1872.
[3] Blum, Die Pseudomorphosen des Mineralreichs, Bd. iii. p. 52.
[4] Von Fritsch und Reiss, Geologische Beschreibung der Insel Teneriffe, p. 423, 1868.

XIII.—ROCKS FROM THE VOLCANO OF TERNATE.

The magnificent view at the entrance of Molucca Pass is well calculated to exhibit the great share which volcanic forces have had in building up the archipelago. The naturalists of the Challenger Expedition who explored these islands were greatly struck by the scene; when fairly in the straits they saw before them on the east coast alone ten volcanic cones, several being in an active state.[1] The volcano of Ternate was then in eruption, and is one of the most important in the group. It has been described in detail by Mr. Moseley, who made the ascent along with Mr. Balfour in October 1874. The rocks they collected on the summit are now to be described.

The island of Ternate, situated close to the equator, in latitude 0° 48′ 30″ N. and longitude 127° 19′ E., is separated by a narrow sound from the island of Tidore. It might be described as a huge volcanic mountain rising from the bottom of the sea and attaining an elevation of 5600 feet above its level, as determined by the Challenger Expedition. The ascent of this volcano is rarely attempted, and the nature of it was hardly known before Mr. Moseley's expedition, the results of which may be summarised thus:—

The island is formed of three superimposed cones, the highest, at the summit of which the actual crater is found, being surrounded by the second, which is in turn planted in the ancient crater that crowns the great basal cone of the mountain. After traversing the cultivated fields and woods which spread over the flanks of the mountain, one reaches the ridge of the ancient crater, at a height of 4800 feet. This crater is about 100 feet deep, and from it rises a second cone to a height of about 4850 feet, from which the cone of eruption springs. The second crater, which may be termed the intermediate, is encumbered with masses of lava thrown out by the crater of the superior cone. The solidified streams are formed of reddish lava cracked in all directions by contraction. The superior cone planted in the intermediate crater is destitute of vegetation. Its height from base to summit is 350 feet; the cliff-like slope rises at an angle of about 30°, and at the summit of the cone descends by a similar slope of 30° into the upper crater. The superior cone is not formed of volcanic ash, but of masses of basaltic lava; the blocks scattered over the surface appear very fresh, as if they had been recently ejected. Messrs. Moseley and Balfour vainly endeavoured

[1] Amongst the volcanoes of the Moluccas we may mention, besides that of Ternate, the little cone of Hieri, an island situated in the north of the group. The cone is about 2200 feet high, circular, and about three-quarters of a mile in diameter at the base. The island of Tidore has the highest and most perfect cone (see Narr. Chall. Exp., vol. i. fig. 199, p. 594, for a view of this volcano). Its height is 5900 feet, and it is situated in latitude 0° 39′ N., longitude 127° 23′ E. The volcano of Mareh, from 700 to 800 feet in height, is formed by two peaks. The volcanic cone of Metir, in latitude 0° 28′ N., longitude 127° 23′ E., is 2800 feet high. The island of Mitara is also surmounted by a small cone, the form of which is remarkably regular. For the natural history and geographical details of these islands, see Narr. Chall. Exp., vol. i. pp. 592–600.

to explore this crater. They could only descend it to a depth of 60 feet, for the suffocating acid vapour which enshrouded them, and the difficulties of the ground, compelled them to return. They found deposits of sulphur in the crevices, and saw everywhere rocks profoundly modified in structure by the action of vapours exhaled from the volcano. The rocks about to be described were collected from the summit of this cone.

The rocks of Ternate belong to the augite-andesites, but in some cases, from the presence of olivine, they ought to be classed amongst the basalts. We shall first describe the andesitic lavas.

The most characteristic specimens are slightly scoriaceous, and of a dark colour; the naked eye and the lens only show some vitreous or white points which are crystals of plagioclase. Microscopically the rock is vesicular; the matrix, chiefly formed of vitreous matter, is devitrified here and there by spherulites, and numerous plagioclase microliths are scattered through the brownish glass.

The large sections of plagioclase are zonary, and full of vitreous inclusions; they exhibit at the same time the twins of the albite and pericline law. Sections, where the lamellæ are twinned following the albite and the pericline laws, appear clearly defined and intercrossing each other at right angles (also parallel to k), and give symmetrical extinctions of from 20° to 16°. These values show that we are dealing with a plagioclastic mixture which approaches labradorite.

Most of the augite sections are twinned polysynthetically. The lamellæ, often resembling those of plagioclase, are sometimes very numerous and closely packed, giving some sections of this mineral a fibrous appearance. The central part of the augite is often the most lamellated. Twinned lamellæ are sometimes noticed in the form of two triangles meeting at the apex, and thus resembling the well-known clepsydra structure which occurs in this species. A rather long augite crystal cut nearly parallel to $\infty \text{P̶} \infty$ showed these lamellæ closely packed in bundles at the centre, but spreading out by the addition of more lamellæ towards the extremities of the section. They thus present an appearance like a sheaf bound tightly in the middle, and show considerable analogy to the internal structure of augite just referred to. The pleochroism $= \gamma$ greenish, β yellowish. This pyroxene has a great angle of extinction; the hemitropic lamellæ intercalated in the principal individual extinguish at 50°, and the large crystal itself at 44°. The cleavage is not well marked, doubtless because the slices cut off this somewhat scoriaceous rock are not so thin as those obtained by polishing a more compact mass. Magnetite, presenting no noteworthy peculiarity, is also an essential constituent of this andesite.

Some other specimens, which must also be classed with the andesites, resemble that just described very closely in their microscopic characters, only the ground-mass is darker, more iridescent, and less vesicular. There are some minor differences also

which must be referred to in detail. Fig. 29 shows a section of plagioclase with hemitropic lamellæ, following the albite law. These belong to two principal individuals, which mutually penetrate each other, and present, each in its turn, a larger development in the different parts of the section. The two principal individual crystals, which sometimes form the groundwork and sometimes the lamellæ, are twinned in the following manner :—

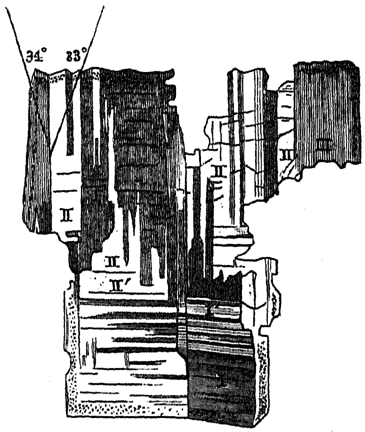


FIG. 29.—Andesite of Ternate. Section of plagioclases, albite, pericline, and Carlsbad twin.

I. II. . . .	Albite twin.
I. I.′ . . .	Pericline do.
II. II′. . . .	do. do.
III. (I. II.) .	Carlsbad do.

Cleavage parallel to the face *P* is noticeable in both individuals. This is shown in the figure by lines sensibly perpendicular to the albitic lamellæ. Extinction takes place at 33° to 34° from on the trace of *M*. The polysynthetic lamellæ following the pericline law (I′. II′), extinguishing at 27°, meet at an angle corresponding exactly to the trace of *PP′*, which is clearly indicated at the lower part of the figure. The third individual (III), joined to the preceding group in the plane *M*, must be considered as forming a Carlsbad twin with (I. II); in fact, this individual gives an asymmetric extinction at 20°.

The augitic sections in this rock show strong pleochroism, recalling hypersthene by the tints observed. We have :—

$$\underset{\text{reddish yellow.}}{\alpha \quad \beta} \qquad \underset{\text{greenish.}}{> \gamma}$$

The form of the augite crystals is not that usually found in andesites, the sections being terminated by an obtuse summit very like those of bronzite. This mineral is sometimes twinned, and the value of its extinction never allows any doubt regarding its correct description as monoclinic pyroxene. The rock we describe has the general characters of an augite-andesite; it contains, however, small hexagonal or rhombic sections of olivine. The ground-mass is a base, enclosing a great number of felspathic microliths, appearing like belonites, and magnetite, which also occurs as inclusions in the constituent minerals.

Another specimen of augite-andesite contains zonary sections of felspar, parallel to *M*, which allow the extinction to be measured accurately. They show that the plagioclase is labradorite (extinction 23°) at the centre, and bytownite (extinction 29°) on the edges. The rock is altered on the surface, and covered with a whitish layer, to which we shall return presently; the undecomposed portion contains 55 per cent. of silica.

A specimen, which must be classed as basalt, presents just the same kind of surface alteration into whitish material; it has been so much decomposed by the action of fumaroles that only felspar and a few grains of olivine can be distinguished. Microscopical examination shows a number of large and sharply defined crystals of olivine with the angles of this mineral and cleavages $\infty\check{P}\infty$, OP. Augite has a reddish tint, more common for this mineral in basalt than in augite-andesites, where the colour is usually green. It occurs in large microporphyritic crystals, and is often found as microliths in the ground-mass, frequently in small prisms forming a zone round larger crystals of the same kind. The plagioclase crystals are twinned according to the albite law, and sometimes according to that of pericline. Sections showing both systems of lamellæ very clearly, and almost parallel to *k*, give extinctions from 30° to 35°, measured from the trace of *M*. This extinction angle classes this felspar near labradorite. The ground-mass is that of an ordinary felspathic basalt.

The action of fumaroles has so penetrated the specimen we are about to describe, that, were it not for its density and structure, one might take it at first sight for a fragment of pumice. Microscopically the alteration appears in the following manner: the ground-mass is composed almost entirely of a quartzose aggregate, in which no well-formed crystals are to be seen, but only grains of plagioclase and augite traversed in every direction by cracks, the augite especially. Some remains of olivine crystals may sometimes be seen. The rock is sprinkled with little brownish patches of a substance occurring also crystallised in small prisms, the appearance and arrangement of which strongly resemble sagenite; but they are so small, so opaque, and so entirely surrounded by the ground-mass, that it is impossible to determine their nature with certainty.

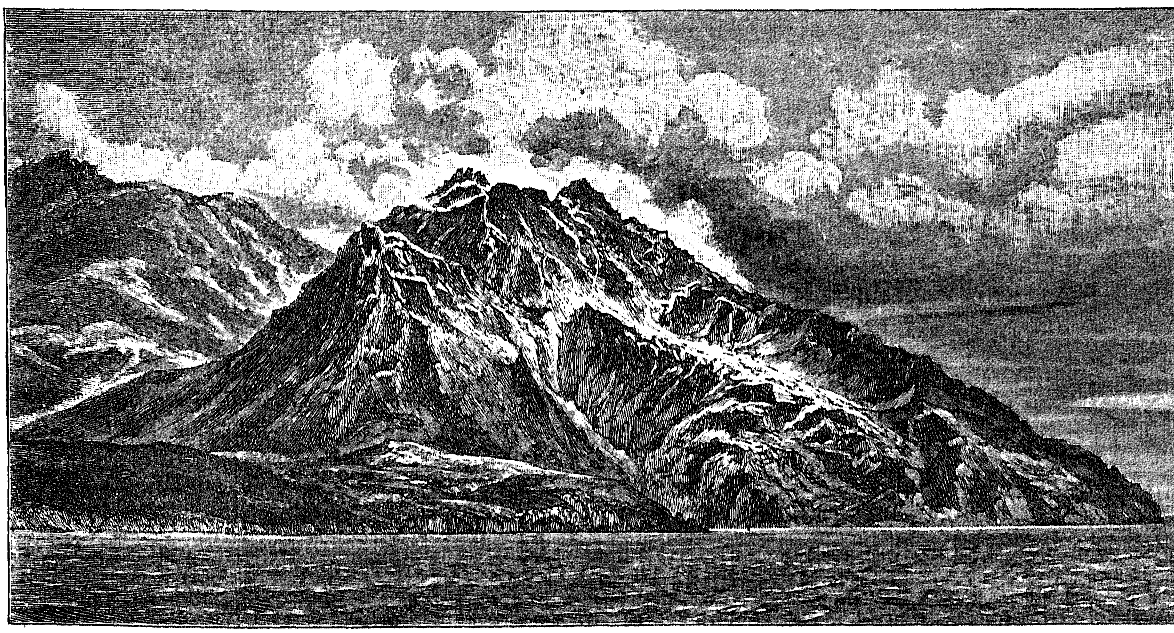
XIV.—ROCKS OF THE PHILIPPINE ISLANDS.

A. *Rocks from the Volcano of Camiguin.*

The island of Camiguin, on which the volcano about to be described is situated, belongs to the Philippine archipelago, one of the most remarkable centres of eruption on the globe. These islands form a link in the great volcanic chain, which, embracing the Kuriles, Japan and Formosa, passes through Mindanao and Sangir, and runs out

towards the Moluccas, dividing there into two branches, one of which trends towards Java while the other stretches eastward to meet New Zealand.[1]

Several of the Philippine Islands have lately been the subject of important geological observations, and to these we shall have occasion to recur. Professor Roth has given an account of the geology of the archipelago in an Appendix to the narrative of the explorer Jagor.[2] This work exemplifies the great erudition and precise knowledge which distinguish this geologist. I wish to mention very specially the results obtained by Von Drasche during his scientific voyage among the Philippines;[3] and, finally, the



New Volcano, Camiguin Island.

excellent monograph, published by Professor Oebbeke, on the rock specimens collected on these islands by Professor Semper.[4] In spite of the peculiar interest which ought

[1] In considering in more detail the relations of the Philippine archipelago to the neighbouring lands, it can be connected with a chain of islands which commences at Formosa, passes through the somewhat scattered groups of the Batan and Babuyan Islands, and runs on to Luzon. At this point the great chain breaks up into a series of secondary chains, which lead to the Sunda Islands. The group of Busuanga and the island of Palawan trend towards the north point of Borneo; the western portion of the peninsula of Mindanao and the Sulu Islands seem to link themselves to the north-east end of Borneo; Luzon, Samar, and Mindanao lie on a curve, the convexity of which is towards the Pacific Ocean. To the south of Mindanao comes the chain of the Sangir Islands, which advances towards the Celebes and the Talant Islands. These latter stretch towards Halmahera. See F. S. Hahn, Insel Studien, p. 49, Leipzig 1883.

[2] Fr. Jagor, Reisen in den Philippinen, Berlin 1873; appendix, p. 333: Ueber die geologische Beschaffenheit der Philippinen. In this notice by Professor Roth are condensed all the observations on the geology of this archipelago which had appeared before the publication of Jagor's book; it contains, besides, a large number of personal observations on the lithology and mineralogy of these islands.

[3] R. von Drasche, Fragmente zu einer Geologie der Insel Luzon, Wien, 1878.

[4] K. Oebbeke, Beiträge zur Petrographie der Philippinen und der Palau-Inseln, Stuttgart, 1881.

to attach to the volcanoes of this archipelago, and the somewhat advanced state of our knowledge concerning the geology of the great islands constituting it, scarcely any precise details were known of the lithological nature of the island and volcano of Camiguin. The specimens collected by the Challenger naturalists make it possible in a certain measure to fill up this blank.

The study of the products of the volcano of Camiguin is, as will be seen, very closely related to the study of the substratum on which it has been formed, accordingly it will not be useless to give a short sketch of the geological constitution of the archipelago. As we have just said, some recent volcanic rocks of this group have been worked out by various able geologists, but the examination of the rocks of the subsoil and of the sedimentary formation have not been the object of such detailed researches.

It has nevertheless been established that the greater part of the underlying rocks of the Philippines belongs to the schisto-crystalline series; on these the sedimentary beds are deposited, and the latter, which are partly to be referred to the eocene period, are in their turn covered over by more recent deposits. There are, besides, to be observed some raised coral reefs, sometimes containing mollusca belonging to a species still living in the Pacific.

Finally, certain eruptive products, which are, according to von Richtofen,[1] later than the nummulitic limestone, are overlaid by deposits that must be referred to the present period. Some of the rocks found at Luzon and Zebu contain fossils of an older period.[2] When describing the rocks of Zebu, it will be shown that certain eruptive rocks of that island ought to be referred to the pre-tertiary series. The existence of granite in the archipelago is a fact of very great importance, and must be taken into account in explaining the origin of the material ejected by the volcano of Camiguin. Von Humboldt[3] points to the north of Luzon as containing masses of that rock. In the same region Jagor collected rocks of the granitic type, but he did not see them *in situ*, his specimens consisting of rounded pebbles. In other parts euphotide, serpentine, diorite, spilites, and epidotiferous rocks have been observed. Crystalline schists, gneiss, mica schists, amphibolites, and chloritic rocks, associated with the older eruptive series, play a more conspicuous part in the geological constitution of the island than do the recent volcanic formations. It is to these ancient schisto-crystalline rocks that certain well-known metalliferous deposits in the Philippines belong.[4]

[1] In Roth, *loc. cit.*, p. 334.

[2] *Ibid.*, p. 333.

[3] See Humboldt, Kosmos, vol. vi. p. 405.

[4] Roth, *loc. cit.*, p. 334. The existence of ancient crystalline rocks in the Philippine Islands is pointed out in several passages in Professor Roth's memoir. R. von Drasche in his geology of Luzon admits that the gneissose rocks, the diabases, and the gabbros form to some extent the framework of the southern part of the island.

These general remarks on the geological nature of this archipelago will suffice as an introduction to the description of the volcano of Camiguin.

This small island is situated between Siquijor and Mindanao, to the north of the latter island, and 80 miles east of Zebu. The volcano of Camiguin, which stands hard by the village of Catarman, was still in an active state when the Challenger Expedition explored it in 1875. It was then re-entering upon a period of repose, after the terrible eruption of 1871. According to the account of that catastrophe, which we borrow from Professor Roth,[1] the islands of Bagol, Zebu, and Camiguin had for some months been suffering severely from earthquakes, until, on the 1st of May 1871, about five o'clock, a mountain near Catarman was rent open; a central cavity appeared, from which ashes and stones were projected amid explosions and clouds of smoke. An elliptical crater was formed, which measured 1500 feet along the major axis, 150 along the minor, and attained a depth of 27 feet. At seven o'clock a second eruption occurred; but, like the first, it sent out no lava streams. After this catastrophe almost all the inhabitants, to the number of 11,000, deserted the island. According to the details furnished by J. G. Gray of the Royal Navy,[2] eruptions took place only in July, and the phenomena of internal activity continued for nearly two months. The hill was entirely formed during this eruption, and according to Mr. Gray it was about two-thirds of a mile in diameter, and 450 feet high. When, in 1875, the naturalists of the Challenger touched at Camiguin with the intention of studying this volcano, its summit rose to a height of 1950 feet. The volcano is situated close to the shore. Its form is that of a dome, resembling, according to Mr. Buchanan, some of the small volcanoes in the Auvergne. When it was explored all traces of a crater had disappeared, neither pumice nor scoriæ were found; the rocks were still incandescent at a dull red heat, and, by night, the mountain was seen crowned with glimmering light. Hot springs gushed from all the crevices at the foot of the volcano,[3] and fumaroles were to be seen everywhere. The vapours which escaped from these had effected profound changes in the neighbouring rocks. According to the observations of Buchanan and Moseley, who collected the specimens we are about to describe, the volcano is situated

[1] Roth, *loc. cit.*, p. 335. This note on the eruption of the volcano of Camiguin appeared in the *Spenersche Zeitung*, No. 167, 1871.

[2] Hydrographic Notices, No. 8, London, 1872.

[3] It is not within the scope of this description to report the very interesting observations which were made at the volcano of Camiguin on the temperature conditions under which certain low plants live. For this point we refer the reader to Narr. Chall. Exp., vol. i. p. 654; but the interest which, from a geological point of view, arises from these questions induces us here to recapitulate the results. At places where the temperature of the hot springs reaches 65° C., the presence of algæ was not observed, but on some blocks that were bathed by the hot water, and rose above the level of the current, greenish spots were noticed. A little below the source algæ were found abundantly in a small pool into which the water fell, and still retained a temperature as high as 38° C. Still lower they were seen growing in the middle of a brook, whose waters reached 45°·3 C., the highest temperature at which these plants were observed to exist at Camiguin. The resistance which these organisms offer to high temperature is the more interesting, since thermal waters are almost saturated with the various salts that result from the decomposition of the rocks they traverse.

on slightly undulating and greatly denuded strata, formed, as can be seen on the shore, of beds resembling trachyte. We shall now describe the lithological nature of the eruptive products that constitute the volcano.

The rocks collected at Camiguin belong to the andesite type; sometimes, as we shall show, augite predominates in them; in other instances hornblende seems to play the leading part, but, in all cases, these two bisilicates are present, and the transition between the amphibolic and pyroxenic andesites is gradual. We shall therefore describe both types together. In general, these rocks are very close grained; the constituent minerals are readily detached from the mass; the colour is greyish passing into reddish on alteration; when the rock is more massive, it is a little darker. With the naked eye or the lens it is possible to distinguish only some whitish glassy grains, which are plagioclases; blunted crystals of black hornblende, or patches of augite approaching a greenish tint, are sometimes seen.

Microscopical examination shows that these rocks belong to two types of andesites, the amphibolic and the pyroxenic, passing from the one to the other through all stages; in some instances, by the presence of olivine, they are allied to the basalts. In all, however, the microtexture and mineralogical composition remain much the same. In a ground-mass, composed chiefly of small prismatic crystals of plagioclase and augite, united nearly always with a colourless glassy base, are embedded large fragments of plagioclase, augite, generally in greenish grains, hornblende without any crystallographic outlines and of a yellowish brown hue; and, lastly, biotite, bronzite, and especially magnetite, which is scattered in small sections everywhere, both in what we call the paste and in the sections of the above-named minerals.

Having now indicated the microscopical texture and the constituent minerals, we shall describe the characters which each of them presents under the microscope. Plagioclase is incontestably the most important and interesting mineral in the andesites of Camiguin. The adjoining figures represent some of the sections of these felspars.

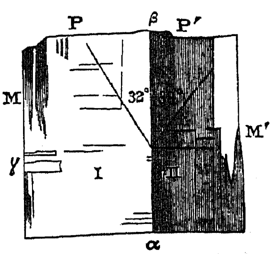


FIG. 30.—Andesite of Camiguin. Section of plagioclase, albite and pericline twins. $\frac{1}{20}$ crossed nicols.

The group represented in fig. 30 shows two individuals twinned according to the albite law. The principal individuals are joined following *M;* one observes the repetition of I and II reciprocally intercalated in each of the two individuals. In the lower part of the figure, the reëntrant angle *α* is formed by the traces of *P* of I and II. In the upper part the obtuse angle is 7° 50′. The double angle of extinction is 70° (32°–38°); *γ* indicates intercalation of lamellæ following the pericline law. The intercalation of these lamellæ shows that the section is very nearly perpendicular to the edge *P*/*k*.

Another mode of grouping is seen in fig. 31; the face *M* of II is superposed on the face *P* of I. This section is nearly perpendicular to the edge *P*/*M* of I; other forms of twinning and different groupings can be seen, such as are represented in fig. 32.

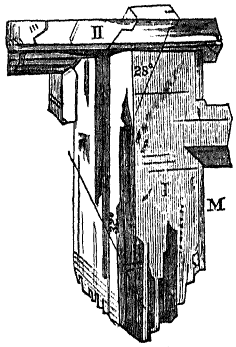


FIG. 31.—Andesite of Camiguin.
Section of plagioclase, nearly perpendicular to *P*/*M*.
$\frac{1}{30}$ crossed nicols.

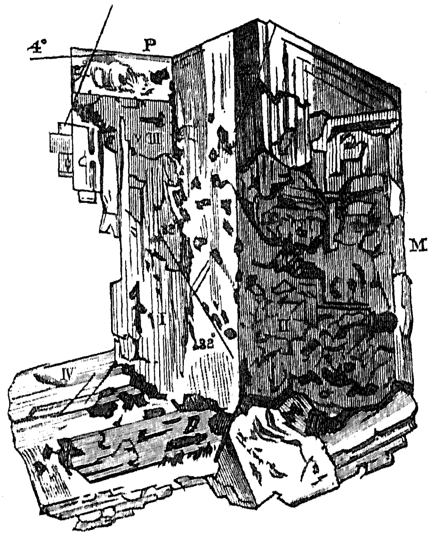


FIG. 32.—Andesite of Camiguin.
Section of plagioclase, Baveno, albite, and pericline twins.
$\frac{1}{20}$ crossed nicols.

This (fig. 32) shows I, Baveno twin; II, twin crystals of albite; I and III, twin crystals of pericline; I, IV, Baveno twin.

Fig. 33 shows I and II Carlsbad twin and one of albite; the extinctions for I are 35° on the average (32° to 38° for *a*, and 32° for *b*). The section then approaches the face *x* for this individual. The individual II extinguishes at 10° for *a* and 6° for *b*; therefore the section for II approaches the face *P*.

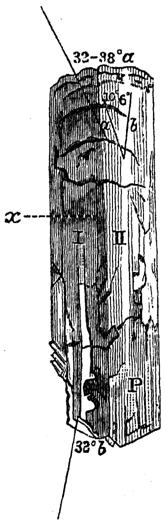


FIG. 33.—Andesite of Camiguin.
Section of plagioclase, albite and Carlsbad twin.
$\frac{1}{30}$ crossed nicols.

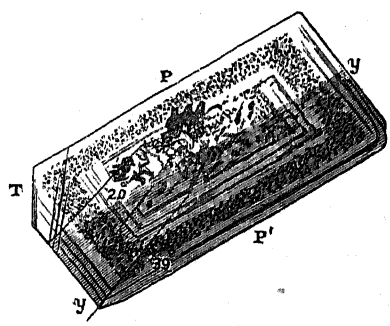


FIG. 34.—Andesite of Camiguin.
Section of plagioclase following *M*, pericline twin.
$\frac{1}{30}$ crossed nicols.

The section shown in fig. 34 is parallel to *M*, and shows a pericline twin. The

two individuals are joined in the plane of the rhombic section; as the figure shows, this plane is visibly inclined towards the face P' in the same direction as the extinction, which is negative and of 39° for one individual, for the other 20°.

The principal characters of the plagioclase in the rocks of Camiguin may be summarised as follows. The optical properties of this mineral, its structure, groupings, and twinnings, indicate that it represents a plagioclastic mixture intermediate between oligoclase and labradorite. One of the most interesting features of this felspar is, that this mineral has crystallised in these rocks with numerous and very well-developed faces; the traces of M P T l x y can be seen in the sections. This abundance of faces is a somewhat rare occurrence, and one to be noticed. The zonary structure is no less remarkable; it manifests itself in all the sections, one may say. For the external and internal zones there are found extinctions of very different values—which point to variations in the chemical composition of the magma at various stages in the growth of the mineral in question. Generally speaking, the extinctions for the internal zones occur at less angles than for the external. We have therefore to admit that the acidity of the magma has been decreasing in proportion as the felspar has gone on developing. In certain cases the various layers of which the crystal is formed have extinctions whose values gradually rise from the central zones to the periphery; in these cases the section presents undulating extinction. This zonary structure is, moreover, characteristic of the intermediate felspars—oligoclase, labradorite, and above all of andesine. No less conspicuous are the twins and groups of which our figures furnish some examples. These plagioclastic sections are almost always striated, following the albite law; often the hemitropic lamellæ are very thin, and appear as simple lines. Twins following the pericline and albite laws are often seen in the same section, sometimes that of albite only. In this latter case the plane of union between the two individuals often appears indistinct. The form of the sections is very variable; some are seen to be symmetrical, with two opposite angles blunted; they are more or less parallel to the face P; the more or less rounded lines are the traces of l and of T. The sections with asymmetrical contours are generally cut in a plane very nearly parallel to M; nevertheless, thanks to the crystalline faces of this plagioclase, we sometimes also notice sections that are parallel to M, and have a symmetrical appearance. They can always be distinguished from the first (sections parallel to P), because the cleavages are not equal, nor are they equally inclined to one another, as is the case with prismatic cleavage. Moreover, the trace of a face may be observed, which makes with one side, alternate or adjacent, an angle approaching a right angle. The face h not being known, one may say, in the felspar in question, the conclusion ought to be that we are here dealing with y, which again proves that the crystal has been cut in a direction coinciding with M, or approaching that plane. The felspathic

microliths of the ground-mass yield extinctions that appear to refer the felspar to labradorite.

Augite is one of the most constant minerals in these rocks; it is found in the pyroxenic andesites, and it is also, although subordinate, always present in the amphibolic andesites. The description we are about to give applies to the augite of both types of andesite. This mineral occurs in microporphyritic sections and in microliths in the ground-mass. The augite of the first generation usually takes the shape of grains without definite crystallographic contours; often these crystalloids are found grouped at one point, where four or five may be seen together. They are traversed by fissures, which sometimes assume the direction of the cleavages; most frequently their direction is irregular. These fissures are marked out by a black coating, which might be considered as due to incipient decomposition; the outer outlines are themselves strongly marked in black, the cleavages being less pronounced; but the most striking feature is the pleochroism which gives $a=\gamma$, green; β, reddish or flesh coloured. The structure is zonary, and the sections often show twinnings of the ordinary type, or twinned groups of two individuals, referable to the type $+P2$. Magnetite may be mentioned as a pretty common inclusion in this mineral. In certain cases the augite shows also inclusions of plagioclase, but, on the whole, it is in the interspaces of the large crystals of pyroxene that we can observe these felspathic inclusions. Augite itself sometimes occurs as an inclusion within sections of olivine. We have just remarked that the decomposition of the augite betrays itself by a network of black lines, and by strongly marked outlines; when the mineral is more weathered a black nucleus is found at its centre. But another kind of decomposition occurs in the microliths of the paste, and in some large microporphyritic grains; they take on a reddish tint, due to hydroxide of iron, which sometimes makes them almost opaque.

The small crystals of augite in the ground-mass belong, without doubt, to a second generation. They are prismatic, much better formed, slightly rounded at the extremities, and, in ordinary light, almost colourless or with a greenish tinge. They are not easily distinguishable from the plagioclastic microliths, except that, when decomposed, they are charged with red ferric oxide. Augite and hornblende are frequently intimately associated in the augitic andesites of Camiguin, especially when the latter mineral shows decided indications of alteration. For instance, a prismatic section of hornblende may be seen terminated at both ends, and edged along the prismatic faces, by greenish microliths arranged parallel to the vertical axis of the crystal they surround. While the yellow amphibolic nucleus extinguishes between crossed nicols at an angle of about 15°, the small crystals of the outer zone sometimes extinguish at 40°, clearly establishing their nature as augite. In other cases no nucleus is found, only some outlines remaining to indicate the previous presence of a hornblende crystal, parallel to the vertical axis of which the small green augite prisms, by which it was

replaced, are arranged. These facts, showing a phenomenon quite the reverse of an uralitisation, are more common and also more distinct as the hornblende is more altered. We may observe that small green crystals of augite also occur bordering sections of olivine, but even although this is the case the olivine is not appreciably decomposed.

Hornblende is represented in all the preparations of the volcanic rocks of Camiguin, and is at once distinguished by its yellow-brown colour, which is sometimes rather dark. Unlike augite, it is never found in the form of microliths, and it always belongs to the first phase of consolidation. The sections rarely present a sharp crystallographic outline; they are always rounded and bordered with a black aureole of magnetite interlaced with pale-green augite microliths. The crystals are often deeply indented and broken, some portions lying at a little distance. The sections show in some cases cleavages of about 124°, and hexagonal outlines corresponding to traces of the prism and of the face $\infty \bar{P} \infty$. Sections parallel to the vertical axis are frequently laminated and broken at the edges, thus acquiring a close resemblence to biotite. Pleochroism is clearly marked, $\gamma > \beta > a$ being observed. This hornblende is often twinned according to the ordinary law. It is unnecessary to discuss the alteration into magnetite and the zone of augitic microliths, still the rock presents the finest examples of this decomposition. It may be followed from one section bordered with some grains of magnetite to another completely impregnated by this opaque oxide or little crystals of almost colourless pyroxene. The hornblende is sometimes zonary, and alteration has not taken place equally throughout the crystal. In such cases a sort of frame of perfectly fresh hornblende may be observed surrounding an opaque nucleus in which magnetite is accumulated. Sometimes large crystalloids of hornblende are joined, without the interposition of a matrix, to sections of plagioclase; this association, one might say this interpenetration, of the two minerals is common enough to be worth pointing out. Sometimes small prisms of hornblende are enclosed in felspathic sections, and the mineral also occurs associated with olivine. The last-named mineral does not always occur in the rock; when it appears it assumes the form of sporadic grains, sometimes grouped in threes or fours, and frequently of considerable size. Olivine does not exhibit crystallographic outlines, but it may be distinguished at a glance from augite, as it is almost colourless or of a pale pink tinge, and from felspar by the fissures which furrow its surface. Some lines of this network of fissures are clearly defined and parallel; examination in convergent light shows them to be arranged following the plane of the optical axes, the cleavage being thus parallel to the pinacoid OP. This mineral is quite undecomposed, being perfectly colourless, except at the edges of the sections, which assume a reddish tint, and it contains inclusions of magnetite and bubbles of gas.

Some comparatively rare but characteristic sections occurring in the rock should be classed with bronzite. Although very small, they are easily distinguished from augite

and hornblende. They present a fibrous structure such as the two minerals just named do not possess in this rock; the colour also is rather greyish, with a scarcely perceptible red tinge. The sections are prismatic, with angular or rounded outlines, often very irregular; they give straight extinction, and some hexagonal sections remain dark during a complete rotation between crossed nicols. The basal sections show polar rings in convergent light. Pleochroism is not very pronounced, in fact one can hardly detect any difference in tint.

Magnetite is shown generally in octohedral crystals or in somewhat large grains, but when these grains are without crystalline form it becomes difficult to say whether the mineral is primary or whether the irregular sections were hornblende now replaced by magnetite.

Amongst the most interesting specimens collected at Camiguin we may mention, in the first place, some fragments the mineralogical composition and texture of which are altogether different from the andesitic volcanic products just described. The rocks now under consideration are undoubtedly granitic, and they must be viewed as portions of the underlying masses torn up and thrown out by the volcano. These inclusions are instructive, because they show the deep modifications produced by the intense caustic action of the volcanic magma in which they were embedded. To the naked eye the specimens appear milky white, speckled with brilliant scales of black mica. The white minerals have a vitreous aspect; the constituent quartz and felspar which compose this granular mass are not easily made out even with the lens. The rock looks as if it were fritted, and crumbles readily into a powder of irregular grains like those of pulverised glass or quartz. Microscopical examination reveals such decided differences of composition and structure, between this rock and those of the volcano, that it must be viewed as not belonging to the same formation as the andesites of the Camiguin volcano, but should be classed with the rocks of granitic type. Thin slices show a distinct granitoid structure in which monoclinic and triclinic felspars, quartz, biotite, titaniferous iron, and minute augitic microliths take part. At the first glance it is seen that some of the principal elements have not the microscopic appearance of the minerals of a normal granite. They are corroded, cracked, full of gaseous inclusions, and, what is in accordance with the principal features, a colourless amorphous material is found infiltrated between the constituent minerals. This substance is perfectly isotropic at the points where it is isolated, and it contains the characteristic crystals which occur in the glassy cement of sandstones vitrified by contact with eruptive rocks. In certain cases this glass appears to be cracked, and to be derived probably from the fusion of the felspar. As the elements are almost never outlined by crystallographic contours, and as they are deeply altered, specific determination is very difficult, especially in the case of the plagioclases. Sections of these felspars are widely dis-

tributed in the rock; they are zonary, and almost always show numerous fine lamellæ twinned according to the albite law; periclinic lamellæ are also sometimes seen. Other sections of triclinic felspar appear to belong to microcline or microperthite; they are slightly milky plates, in which some more or less lenticular intercalations of another felspar appear, resembling the inclusions of albite in microcline. Orthoclase appears in nearly opaque milky sections, rarely twinned according to the Carlsbad law, but, on the contrary, almost always forming a single crystalloid without interpositions of hemitropic lamellæ. The two cleavages at right angles, which characterise this species, are apparent in some cases. This felspar, which seems more altered than the plagioclase, shows yet no trace of decomposition into micaceous matter, nor of saussuritisation. The sections extinguish uniformly. It appears probable that this mode of decomposition is due to an action of a special nature. The orthoclase is often seen bordered with a vitreous zone due to the fusion of the felspathic matter. Although no vitreous inclusions are to be seen, the sections of felspar are riddled with air-bubbles. Quartz in irregular grains is recognised by its brilliant colours in polarised light, and the arms of the cross of monaxial crystals appear in convergent light. This mineral is remarkably fissured and split, being also filled with gaseous inclusions such as are observed when quartz is fused in fulgurites for instance. No liquid inclusions are to be seen, but some fine vitreous ones have been observed; these are in all probability of secondary origin. This mineral is represented in the microscopic preparations by numerous sections showing clearly all the characters of the species. Biotite appears in the form of dark-brown strongly pleochroic sections. The outlines are irregular and black, but not opaque at the edges, as is common to the hornblende of the andesites and of the basaltic lavas. This mica presents no noteworthy peculiarities, except that a number of excessively minute microliths of a very pale greenish colour are attached to the broken edges. Some of these little prisms extinguish at angles which may rise to as much as 40°; they should be classed as augite. It is also to be remarked that their long axes are arranged in directions more or less parallel to the pinacoid of the mica they surround. Augite has also crystallised as inclusions in the interior of the biotite. Here we have facts which bear a close analogy to what has been observed in the case of the hornblende of the andesites. Everything leads to the conclusion that, in the embedded as well as in the eruptive rock, the formation of the little crystals around mica or hornblende must be due to the same caustic action. Irregular granules of titaniferous iron, sometimes surrounded by a zone of rutile, are found in the altered granitic rock.

Finally, we may mention amongst the ejected rocks fragments of quartzose rocks which were embedded in the eruptive mass. These are milk-white in colour, and extremely fine grained in texture; they have a fritted appearance like the granite just described, and they are furrowed by fissures of contraction. This appearance of the specimens plainly shows that they have been submitted to intense heat. A zone of

fusion marks the place where they are united to the eruptive rock; the quartzite, assuming a darker colour, passes insensibly into andesite. The alkalies present in the andesite doubtless acted upon the silica of the quartzite to produce this zone of fusion. The embedded fragments measure 4 or 5 centimetres; some smaller specimens were seen, but they have almost entirely fused, assuming an opaline appearance. Microscopic examination shows that, except in the zone of fusion, these quartzites are made up of irregular grains of quartz, without any amorphous matter. Very small greenish crystallites grouped in gerbs or fans, and imbricated scales of tridymite, are observed in the quartzites.

B. *Rocks of Zebu and Malanipa Islands.*

THE few specimens from these two islands of the Philippine group which we will describe were collected by Mr. Buchanan in the course of a hurried exploration, and they represent some only of the lithological types which are characteristic of these islands. The specimens deserve attention, because these localities are rarely visited by geologists, and because the rocks allow us to extend to these islands, with great probability, the interpretation admitted for the larger islands of the group, regarding the schisto-crystalline nature of the archipelago, and the presence of ancient eruptive rocks.[1] These researches also allow us to generalise another order of phenomena, which has been observed in other islands of the group, viz. the alteration of volcanic rocks by the action of sulphurous emanations. It is well known that no fumaroles containing hydrochloric acid have been observed in the larger of the Philippine Islands, while sulphurous fumaroles play a considerable part in the decomposition of rocks in that locality. We shall see that the massive eruptive rocks of Zebu have undergone the action of sulphurous vapours like those of all other parts of the archipelago.

The island of Zebu, famous for the death of Magellan, has been long known to naturalists, since it is almost the only locality where the beautiful siliceous sponge *Euplectella aspergillum* was formerly dredged. Zebu is 120 miles long, from 10 to 17 miles in breadth, and has an area of about 1200 square miles. It is traversed from north to south by a chain of mountains, and contains deposits of lignite which are being worked.[2]

The rocks to be described were collected in the neighbourhood of the town of Zebu, where they are exposed in the bed of a river. One of them is a greenish black fine-grained specimen; little lamellæ of plagioclase are seen sparkling, with the naked

[1] Mr. T. E. Tenison-Woods has published a resume of his researches on the geology of Malaysia, the south of China, &c. (see *Nature*, vol. xxxiii. p. 231, 1886). His conclusions with regard to the nature of the geology of Malaysia and the Philippines agree closely with those put forward by Professor Roth in the appendix to Jagor's work, and with those derived from researches on some rocks from the island of Camiguin. The vast region examined by Mr. Tenison-Woods presents a remarkable uniformity in geological structure. Granites and intrusive rocks form the lower masses, and are covered by palæozoic schists and slates. In some places beds of limestone, probably carboniferous, appear, and finally deposits of coal belonging to different formations. Marine deposits of miocene and pliocene age were also observed.

[2] For the age of the coal and lignite beds of the Philippine Islands, see Tenison-Woods, *loc. cit.*

eye, in the ground-mass, and with the lens some grains of olivine may be detected. These minerals are enclosed in a dark-coloured matrix. The rock has a plane fracture. The microscopic texture is microporphyritic, and felspar and augite are present as large crystals or as microliths. The latter, grouped in the ground-mass, belong to a second generation. Olivine often appears in rather well-formed crystals. The felspathic sections exhibit the interesting peculiarity of being sometimes twinned according to the Baveno law; two individuals with plagioclastic striæ are joined at right angles, and extinguish simultaneously. These hemitropic lamellæ give symmetrical extinction at 17°. Hence the felspar may be classed as labradorite or bytownite. The twin of pericline is rarely seen, and the crystals of plagioclase are generally broken and corroded by the action of the magma. They preserve their freshness only in certain parts of the section. They are usually covered with a network of viridite, which also penetrates the larger constituents of the rock. Augite appears as a rule in patches without regular outlines, and this mineral is even more corroded and broken up than the felspar. Crystals of augite are often seen broken into a number of fragments which are piled up one on the other, yet they may readily be reconstructed, for the corresponding pieces bear the form of the primitive octagon of sections perpendicular to the vertical axis. The cleavage and optical properties leave no doubt as to the determination of this mineral. It is sometimes twinned according to the ordinary law, and its pleochroism is very slight. One can hardly see any difference in the absorption of rays vibrating parallel to a and to γ; both are green. The augitic sections are penetrated by the same greenish substance which forms veins in the felspars, and they are also surrounded by a zone of pyroxenic microliths similar to those of the ground-mass.

The olivine is entirely altered, and only pseudomorphs of it by serpentine are to be found, but these furnish exact models of the primitive crystals. The pseudomorph polarises in blue tones; this homogeneous tint is not that usual in this alteration product of olivine. Its sections are traversed by threads of opaque black granules arranged parallel to the cleavage. These dotted lines trace out blunt-angled squares. In the interspaces of the crystal, which sometimes correspond to the cleavages, calcite has crystallised, and from these it extends in somewhat thick veinules, which subdivide into fine ramifications, penetrating the serpentinous matter. Minute patches of calcite are also seen in the ground-mass. Magnetite occurs in rather large sections, but in this case it is never bounded by crystallographic outlines, and like most of the minerals composing this rock it shows traces of corrosion.

The ground-mass, in which fluidal structure is distinctly marked, is made up, with the exception of olivine, of the minerals which have just been described. Felspar and augite assume the form of microliths, and viridite penetrates all the interstices between them.

Another rock from the same locality showed on examination a composition and structure identical with that just described. The one detail to note is that epidote was found in yellowish grains included in the felspar. Although this mineral plays a purely accessory part, its presence has a certain significance, in relation to the determination of the age of the rock in question.

At first sight one is tempted to refer these rocks to basalt, for they have the same composition and structure, but on taking their mode of decomposition and the presence of epidote into account, it seems more natural to class them with the melaphyres and peridotic diabases. It is known besides, as pointed out in speaking of the rocks of Camiguin, that palæo-volcanic masses are represented in the Philippines. There is nothing surprising, therefore, in finding rocks of the diabase family on this island. We must, however, add that this determination as palæo-volcanic rock cannot be established with certainty in the case under consideration so long as there are no stratigraphical data to found upon.

We shall now describe the altered specimens and the secondary products formed by the action of fumaroles. One of these decomposed rocks is formed of a mass of whitish grey clay with a greenish tinge; it is friable, and may be scratched by the nail. The naked eye distinguishes small bright crystals of pyrites, and sometimes milky grains of felspar. The specimen is covered in some places with a coating of limonite, and gives out a strong argillaceous smell. Microscopic examination shows that the alteration has principally affected the ground-mass and the bisilicate, which must formerly have been a constituent, and has now entirely disappeared, giving rise to chlorite surrounding all the elements. The felspar is sometimes transformed into saussurite, granules and characteristic needles of which are found in the plagioclastic sections. The plagioclase is still fresh enough in some cases to show hemitropic lamellæ according to the albite law, and the primitive outline of this mineral may sometimes be traced out. In a section parallel to M traces of the faces PyT are seen, and the cleavage parallel to P, and also those of the prisms less marked. It is thus possible to estimate the angle of extinction accurately enough, and the mean of observations gave $+20°$ for the plagioclase. This felspar thus approximates a mixture of oligoclase and albite. The rock may be classed with diorites rich in felspar, if we admit, as is probable, that the bisilicate was formerly represented by hornblende. It is well known that the presence of oligoclase has often been proved in rocks of this type, and even albite has been observed in diorites. Epidote, of which some grains are occasionally found, also leads to this determination.[1] Numerous sections of pyrites, also a secondary mineral, are frequently observed.

[1] We must note that epidote is found in recent eruptive rocks, for example, in amphibolic andesite (compare J. Roth, Chem. Geol., p. 351), but it is no less true that this mineral is comparatively rare in the crystalline masses of that age, whilst it abounds in the older amphibolic plagioclastic rocks.

We ascribe the decomposition of this rock chiefly to the action of fumaroles. The same explanation must also be given for the presence of gypsum associated with pyrites at Zebu. Specimens of this mineral collected in that island show a compact and whitish mass, sometimes laminated, and enclosed by a crystalline coating of pyrites; some of these crystals have the form of cubes, others of pentagonal dodecahedra. Under the microscope the mass of gypsum appears as an aggregate of entangled crystalline lamellæ, which assume brilliant colours in polarised light. Some of the sections show rectangular cleavages, and ought perhaps to be classed as anhydrite. Colourless hexagonal sections with one optical axis, and presenting all the characters of quartz, are to be seen in the microscopic preparations. These little crystals of quartz, which are often associated with gypsum, are microscopic, perfectly colourless, and contain liquid inclusions.

We have attributed the alteration of these rocks and the formation of the secondary products described above to the action of fumaroles. The effects of these emanations are generally observed in volcanic regions, and in the Philippines they occur on a large scale, for although, as stated above, there are no fumaroles of hydrochloric acid, those charged with sulphuric acid are very numerous, and perfectly explain the products of alteration we have described at Zebu.

The action of sulphuric acid fumaroles on eruptive siliceous rocks should produce gypsum, alum, hydrated aluminium, sulphate, and bianchetto, and according to the intensity and duration of the action, the alumina is eliminated or converted into sulphate. The deposits of gypsum are here explained by the decomposition of minerals of which lime is the base—hornblende, augite, and felspar, the presence of which in the rocks of the island we have pointed out. The formation of pyrites is similarly explained by the alteration of the iron-bearing minerals of the crystalline rocks. Analogous phenomena are common in many other parts of the Philippine archipelago. It suffices to recall that Mr. Semper has observed them at the sulphurous spring near Maquilin, and Professor Roth cites a great number of localities where Dr. Jagor has observed facts similar to those we have mentioned.

The little island of Malanipa, where the few rocks about to be described were collected by the naturalists of the Challenger, like Zebu, belongs to the Philippine archipelago. It lies near Samboagan, bearing N. 66° W. from that island, and has an altitude of 360 feet above sea-level.[1] The specimens examined are serpentinous rocks derived from the decomposition of peridotites.

One fragment of serpentine is traversed by veins of chrysolite; the rock itself is black and shining, spotted with green. Dark particles 3 to 4 millimetres in diameter,

[1] Narr. Chall. Exp., vol. i. p. 605.

and presenting a metallic lustre like bastite, stand out from the ground-mass. Microscopic examination shows that this serpentine is an alteration product of pyroxenic peridotite, with granitoid texture. The olivine sections are often found altered, the mineral being almost always invaded by pale yellow or colourless serpentinous matter. The alteration has not affected enstatite so seriously; some fibrous sections of this mineral are to be seen, and the optical properties, although already somewhat uncertain, indicate a non-pleochroic rhombic pyroxene.

The serpentine in another specimen is clothed with a coating of chalcedony; the yellowish green serpentinous matter is brecciated, and the fragments cemented together by filaments of chalcedony. Under the microscope sharp angular splinters of serpentine are seen presenting the usual characteristics of this substance. There is no trace of a primary mineral remaining. The chalcedony appears either as a fibro-radial aggregate, showing the black cross of spherulites, or as a fibrous structure, composed of extremely fine needles. The association of these veins of chalcedony with serpentine may be explained by the silica eliminated, when the latter mineral was formed from the original rock.

Serpentine is not the only substance formed by the decomposition of magnesium silicates; another mineral produced in a similar way appears at Malanipa in a state of remarkable purity. The fragments in question are white and close grained, hardly to be scratched by steel, and breaking with a sub-conchoidal fracture. The surface is covered with irregular mammillations showing its concretionary nature. Chemical analysis shows that this substance is almost exclusively carbonate of magnesia, and the specimens represent a type, which is remarkable for its purity, and which possesses the mineralogical characters of magnesite. This mineral is frequently associated with altered rocks containing silicate of magnesia. Thin slices of magnesite when examined by the microscope are found to be made up of an aggregate of very small crystalline grains melting into each other, and not defined by crystallographic outlines. This greyish basis is grooved by microscopic fissures, along which larger grains of magnesite appear, with more distinct contours, and even surrounded by a slight irisation like the calcite grains in limestone. The fissures are lined by a yellowish brown fibrous coating of serpentine.

Finally, one of the specimens from Malanipa is a piece of calcareous tufa, similar to that found on many other islands, and described particularly when speaking of Fernando Noronha. The naked eye only distinguishes greenish black rounded grains of serpentine amongst the constituents of this pale yellow tufa, but the microscope shows the rock to consist almost entirely of fragments of the shells of calcareous organisms, the interiors being often lined with fibro-radial calcite. Little crystals of calcite, formed *in situ* and of indefinite outline, may be seen sparkling on the edges of fragments of shell.

XV.—ROCKS OF THE ISLAND OF JUAN FERNANDEZ.

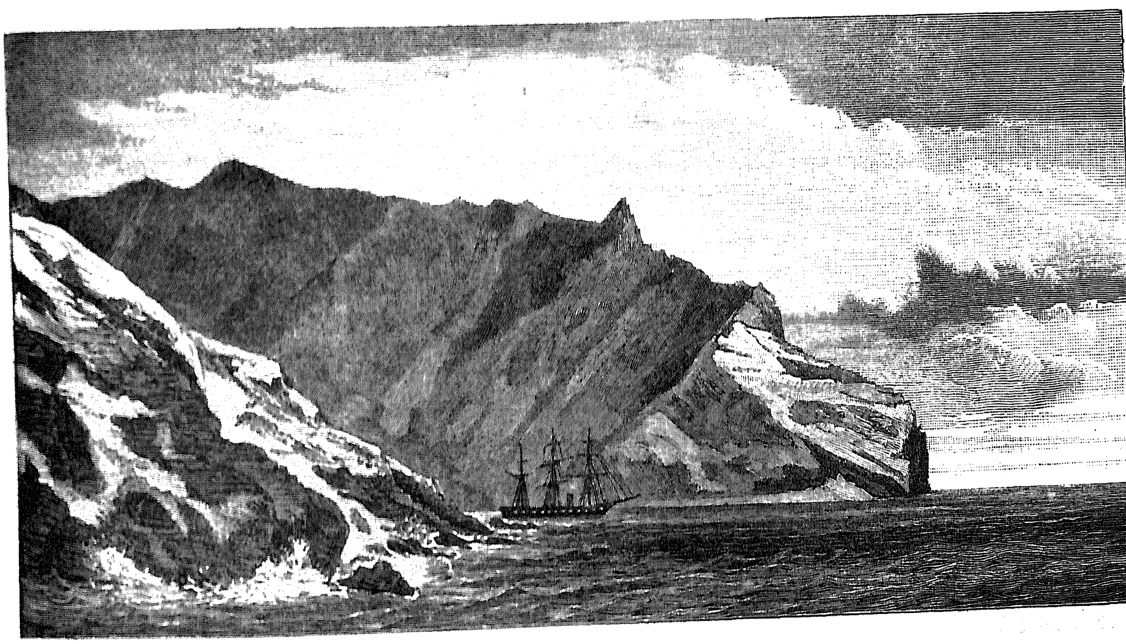
THE coasts of Chili, like all those of Western South America, have relatively very few large and profound indentations, and there are few islands in the adjoining ocean. With the exception of the Galapagos Islands, well known from Darwin's description, and those of Juan Fernandez, the only islets to be found along this coast are those of the Fjords, situated southward of the continent, and which belong to the older formations of Patagonia. The group of Juan Fernandez[1] is composed of several islands, the most important of which, bearing the name of Juan Fernandez or Mas-a-tierra, is famous from the sojourn of Alexander Selkirk, hero of Defoe's "Robinson Crusoe." With regard to natural history, Juan Fernandez has most interesting characteristics, which have long ago attracted the notice of zoologists and botanists. This islet, only a few miles in extent, is inhabited by birds and terrestrial molluscs, and covered by trees and ferns, which are not to be found on any other part of the globe, except perhaps at Mas-a-fuera, a little neighbouring islet. As just remarked, the fauna and flora of this group of islands have been already closely studied, but such is not the case with its geology, which is as yet but vaguely known.

The group is composed of Juan Fernandez, Mas-a-fuera, Santa Clara, and the little Goat Island; they are surrounded by numerous rocks, which rise to the surface at a short distance from the shore. Juan Fernandez, where the rocks that we shall presently describe were collected, is situated in lat. 33° 37′ 45″ S., long. 78° 53′ W. (Fort Juan Baptista); it measures 13 English miles by 4, with an area of 28 square miles. From the monument erected to Selkirk's memory by Commodore Powell and the officers of the "Topaze," the whole island may be seen; it is crescent-shaped, curved from E. to W.; a channel, 1 mile in width and 19 fathoms deep, divides Juan Fernandez from the islet of Santa Clara. The island rises into a peak, and is surrounded by high black cliffs intersected by deep gullies, where the most splendid vegetation is to be found. A mountain, called the Anvil (El Yunque) from its remarkable shape, surmounts the cliffs.

The rocks collected show (as already indicated by the shape of the island) that Juan Fernandez is composed of volcanic materials, but no crater nor recent flow of lava is to be seen. The shape of the island, the nature of its rocks, must cause Juan Fernandez to be classed, with regard to physiography, amongst the oceanic islands formed by the remains of ancient volcanoes, which do not any longer show the complete volcanic

[1] For the physical and political geography of these islands, see Wappäus, Panama, New Grenada, Venezuela, Guyana, Ecuador, Bolivia, Chili, geographisch und statistisch dargestellt, p. 850, Leipzig. The natural history of Juan Fernandez, and the questions relating to the fauna and flora, are summed up in Narr. Chall. Exp., vol. i. pp. 818 *et seq.* A bibliography, almost complete, of the works on this group of islands is to be found there. See also Hahn, Insel Studien, p. 108.

superstructure, but from which the crater and accumulation of tufa have disappeared. It is therefore probable that Juan Fernandez, the other islands composing the group, and the reefs which surround them, belonged formerly to a volcano whose lighter products have been disaggregated and carried away by mechanical agencies. These islands being situated at a relatively short distance off an essentially volcanic region, it is quite possible that the former eruptions of Juan Fernandez were related to those of Chili. It has been ascertained that, when the latter country was devastated by great earthquakes, phenomena connected with those on the Chilian coast were observed in Juan Fernandez Islands. In the year 1855 thick columns of vapour, rising from the sea, were observed at the distance of an English mile from the western island, and the close proximity of a volcanic centre seems therefore to be implied.



Cumberland Bay, Juan Fernandez.

Amongst the rocks collected at Juan Fernandez by the Challenger Expedition in 1875, we have not, however, found any specimens which might belong to very recent eruptions; no tufas, no volcanic ashes are to be found, and everything seems to prove that they have been washed away by the waves and the atmospheric denuding agencies. The rocks which have been submitted to examination all belong to the basaltic type, and it seems probable that the whole island is made up of those that we are about to describe.

The rocks which form the central mass of the island appear in the specimens as dolerites or as common basalts. They have a tolerably fresh appearance, their colour is bluish grey, the fracture is even, the grain is compact, very few vesicles are seen.

With the lens some glassy white felspathic grains are to be seen; others are dark and ought to be ascribed to olivine, augite, or magnetite; the rock is slightly stained with little spots of limonite.

Under the microscope these rocks appear to be entirely composed of crystalline elements, the structure is that of dolerites; between the felspathic lamellæ the augite has crystallised; little sections of magnetite and some skeleton crystals of olivine are scattered amongst these minerals. The lengthened sections of plagioclase are twinned according to the albite law. It has been possible in one case to measure the extinction on a section almost parallel to the face M, clearly ended by the traces of the faces x and P; the value of the extinction was $-17°$. This plagioclase is consequently very closely related to labradorite. The olivine is to be seen, like the augite, in the shape of grains without distinct crystallographic outlines; it is rather difficult at first to distinguish these two minerals, but, besides the optical properties, it is observed that whilst olivine is colourless, the augite is slightly tinged with pink. The cleavages of the latter mineral are also more distinct, the olivine being more decomposed, and its grains often rounder than those of augite. The sections of olivine offer no noteworthy characteristics. We will only mention that the alteration undergone by the olivine is shown by a certain fibrosity, and that the grains of this mineral are often surrounded by a zone of small augitic microliths belonging, most probably, to a second generation. The pyroxenic element of this dolerite is, as we have just said, generally granular; more or less lengthened sections are sometimes visible, as also sections perpendicular to the vertical axis, showing the characteristic cleavage of augite. The colour of this mineral is here light pink, without perceptible pleochroism; sections parallel to $\infty \bar{P} \infty$ divided in four parts, showing the hour-glass structure, are to be observed. Some of the augite is twinned, the two individuals having for composition-plane the dome $-P\infty$. This mineral is also to be found in small granulations scattered between all the constituent elements. The magnetite occupies an important place in this dolerite; its sections are often lengthened, it frequently presents groups of small crystals, and it is found, as inclusions, in plagioclase and olivine.

Other specimens of the rocks which, together with those just described, form the central mass of the island, are not of doleritic structure; they are common felspathic basalts. They are not so dark in colour as the dolerite, their grain is finer, and the fracture is large and even; with the naked eye or with the lens, olivine alone is seen in large crystals 3 to 5 mm. in diameter. This mineral gives the rock a porphyritic structure, and is embedded in a fundamental mass of homogeneous appearance. The altered specimens show on the surface projecting peridotic crystals; the rock weathers into balls with concentric layers. The microscopic preparations show that this rock possesses the common basaltic texture; fine plagioclastic lamellæ with few polysynthetic twins are interwoven with grains of augite with indistinct outlines. Quantities of small

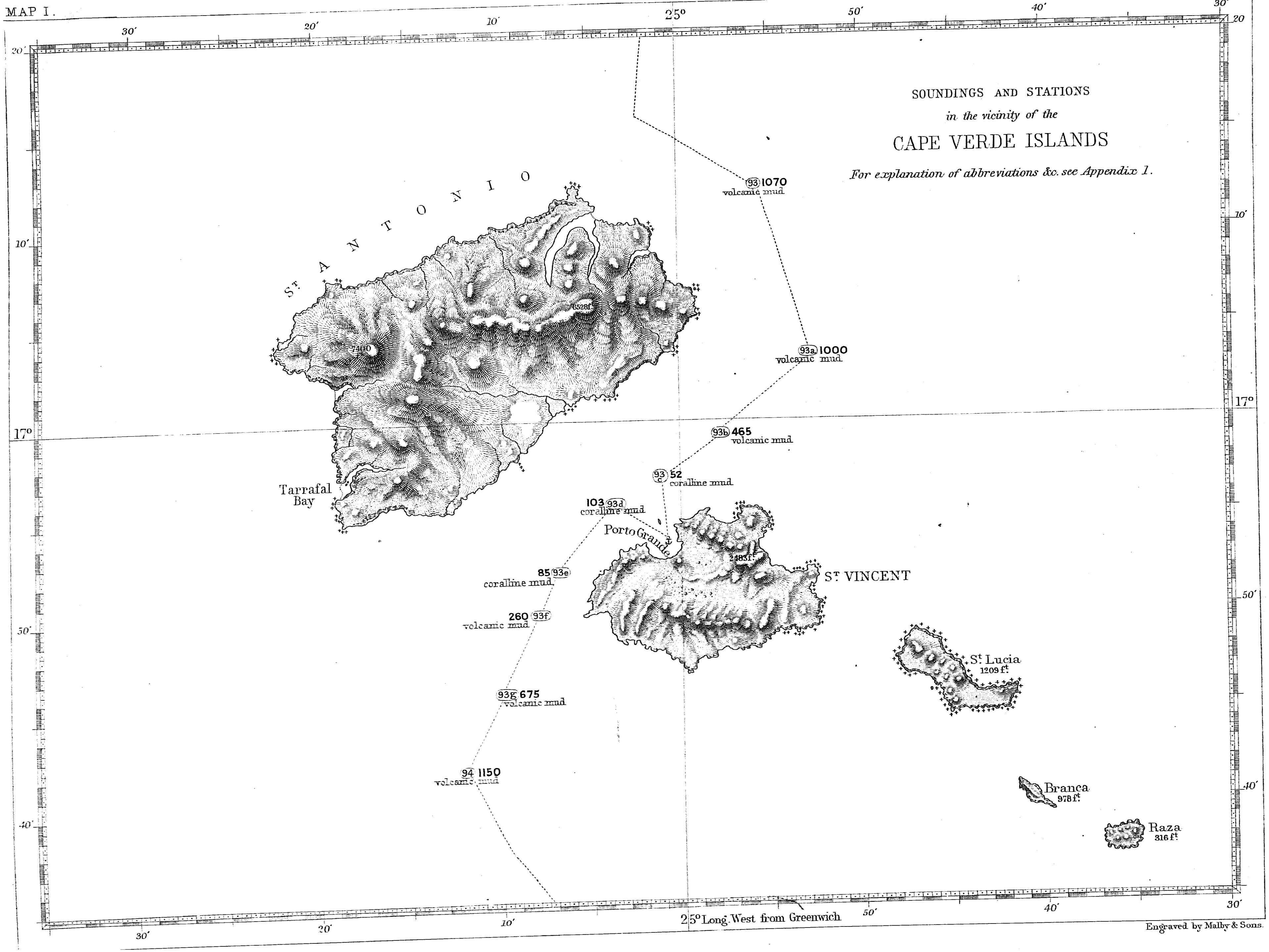
sections of olivine are to be found in this fundamental mass, among which no glassy matter is seen. This mineral plays an important part as a porphyritic element; it is found in the microscopic preparations in large sections with usually rounded angles, bordered by a zone coloured yellow with hydroxide of iron; this zone follows exactly the outlines of the crystals, and lines all their crevices. Sometimes three or four crystals of olivine are grouped together, often several individuals are coupled with their vertical axes parallel. A striking characteristic of these sections is that they present two equal rectangular cleavages, which, at first sight, makes them look like sections of augite; the cleavage parallel to the face $\infty\bar{P}\infty$ is generally observed, but the cleavage parallel to $\infty\breve{P}\infty$ is here as clearly marked. Several sections of olivine, with hexagonal outlines, are ended by an obtuse dome of about 103°; these sections must be parallel to a face of the prism, for an optic is seen exactly in the centre of the field. The long sides of such a section are traces of the faces of the prismatic zone (prism or pinacoid). The angle of the summit does not correspond with the dome $\bar{P}\infty$ nor with $\breve{P}\infty$; it must be therefore ascribed to a pyramid. This face of a pyramid more lowered than the aforesaid domes forms the obtuse angle so often observed in the olivine of basaltic rocks.

The rocks near the monument erected to Selkirk's memory are of the same character as the dolerites and basalts just spoken of. These specimens have the same appearance as the basalts with large crystals of olivine, but this mineral is not visible with the naked eye, the rock is more vesicular; with the microscope it is seen that the texture of this rock is more like that of a dolerite. The lamellæ of plagioclase are very narrow as in the former case, symmetrical extinctions have given almost an angle of 30°. The augite is moulded on the other constituent minerals; sometimes it is to be observed with the clepshydron structure; it appears in the fundamental mass in the shape of grains. Sometimes the augite is macroscopic, and seems to take the place of olivine. The latter is again to be observed in sections with an obtuse top; this mineral is bordered by a zone of hydroxide of iron. A vein of limonite runs through the whole of the microscopic slides. Viridite has been deposited in some spots.

Among the specimens collected on the coast of Juan Fernandez it is necessary to mention a greyish very scoriaceous rock, from which stand out large crystals of plagioclase, of waxy and milky appearance, lengthened following the edge P/M. This rock is a dolerite with large vesicles, the only difference between it and the formerly described rocks being in its structure. Under the microscope the fundamental mass, in which the plagioclase crystals are embedded, has a doleritic structure. The felspathic crystals, with multiple polysynthetic twins according to the albite law, show large extinctions (38° to 41°), which may be compared with those of bytownite; often two large individuals cross each other. The sections of this mineral are cracked and pervaded with zeolitic matter, which forms an irregular network. This matter, which

looks slightly grey when seen by ordinary light, remains obscured between crossed nicols. The augite is seen in roughly formed grains embedded between the felspathic sections. The olivine, of which large sections are seen, is uniformly changed into red hematite ; these sections, however, still show extinctions like those of unaltered olivine. In this rock, as in all the other rocks of Juan Fernandez, magnetite is often observed in elongated sections. In addition to the products of decomposition of plagioclase and olivine, small patches of olivine are to be seen. Some other specimens collected on the shore differ neither in structure nor in mineralogical composition from those just described. It is consequently to be inferred that Juan Fernandez is principally composed of basaltic rocks.

MAP I.



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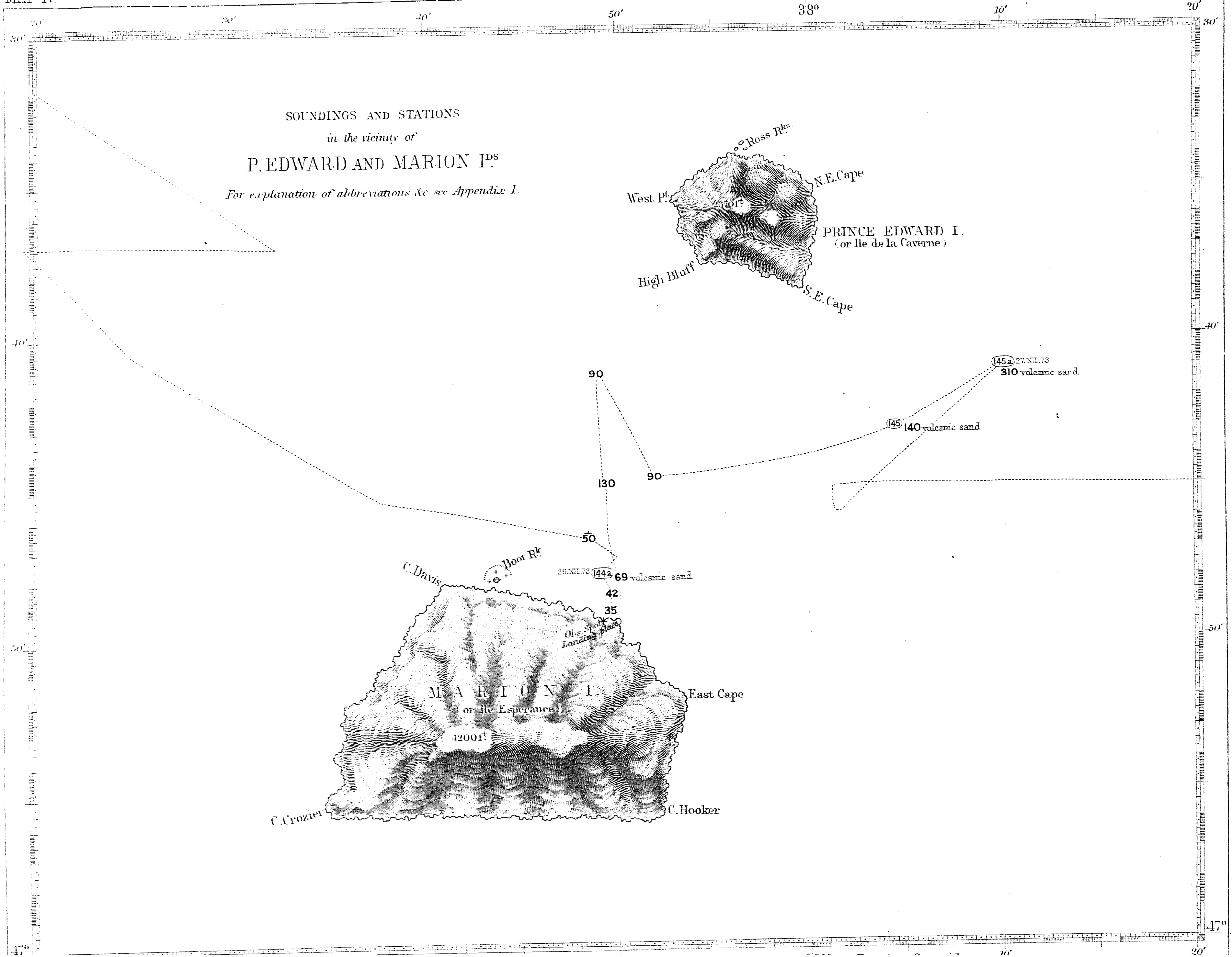
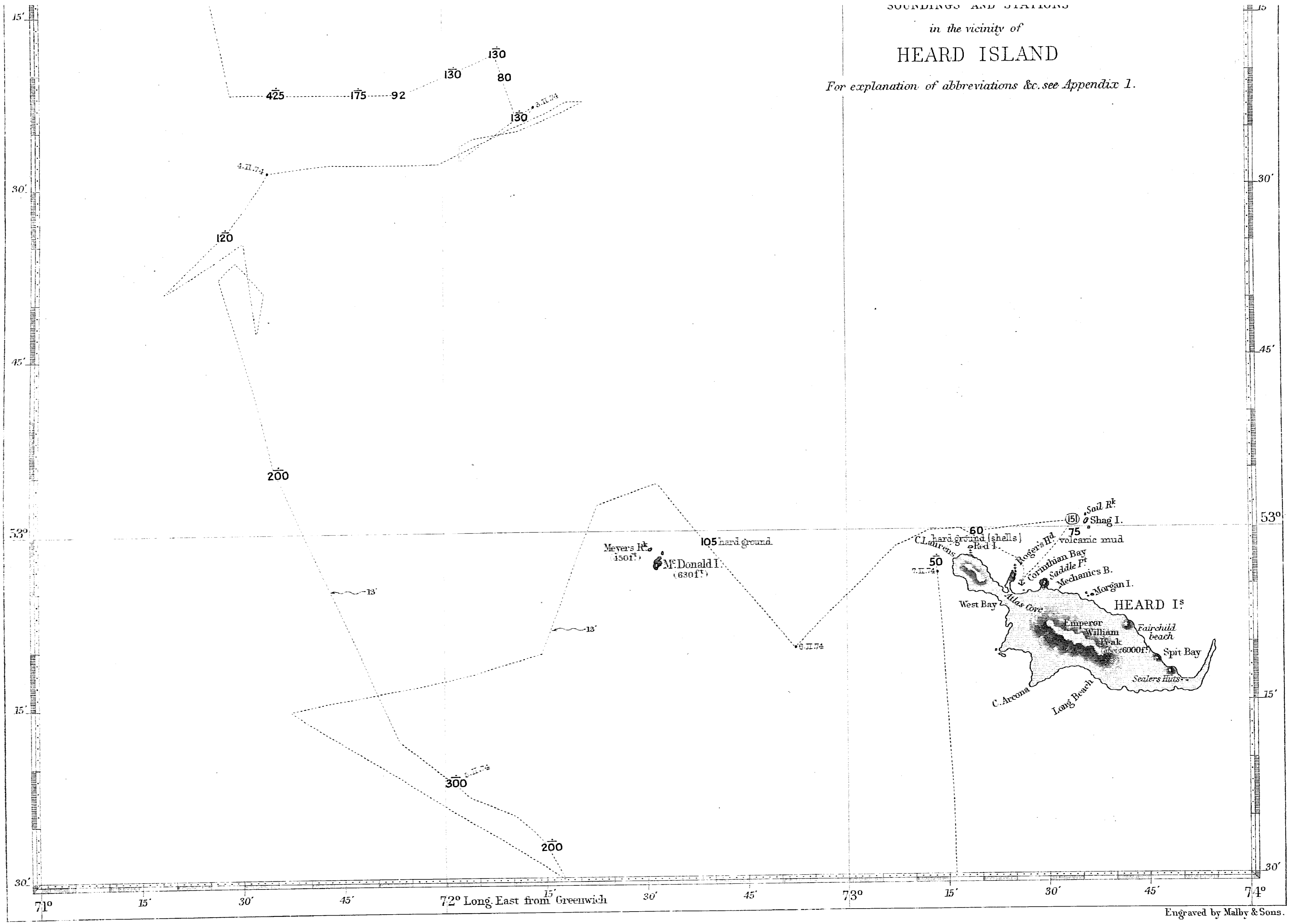

SOUNDINGS AND STATIONS
in the vicinity of
P. EDWARD AND MARION I^DS.
For explanation of abbreviations &c. see Appendix 1.
Ross R^ks.
N.E. Cape
West P^t.
2370f^t.
PRINCE EDWARD I.
(or Ile de la Caverne)
High Bluff
S.E. Cape
145a 27.XII.73
310 volcanic sand
145 140 volcanic sand
90
90
130
50
Boot R^k.
C. Davis
26.XII.73 144a 69 volcanic sand
42
35
Obs. Spot
Landing place
MARION I.
(or Ile Esperance)
4200f^t.
East Cape
C. Crozier
C. Hooker
38°
47°
10'
20'
30'
40'
50'



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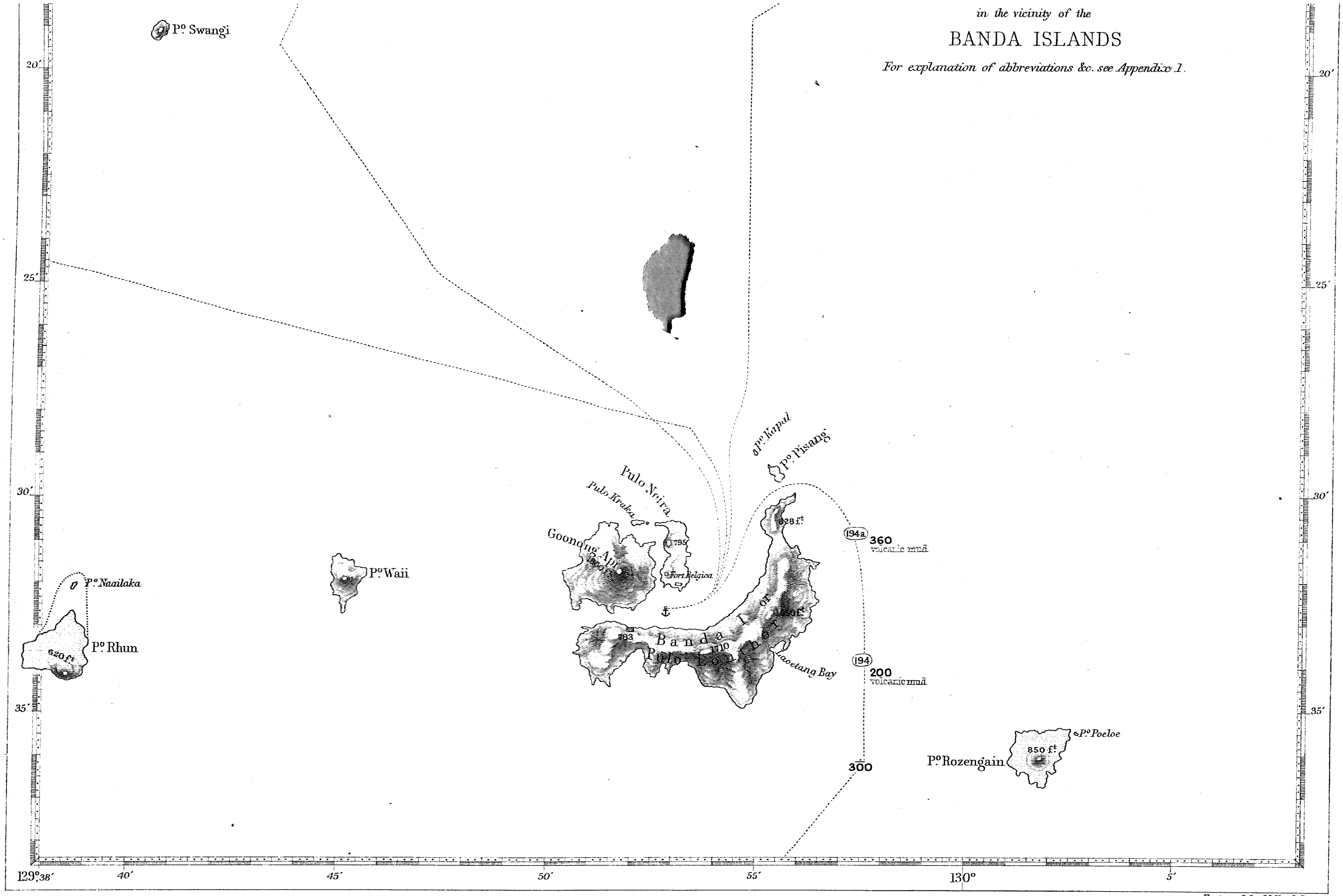

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